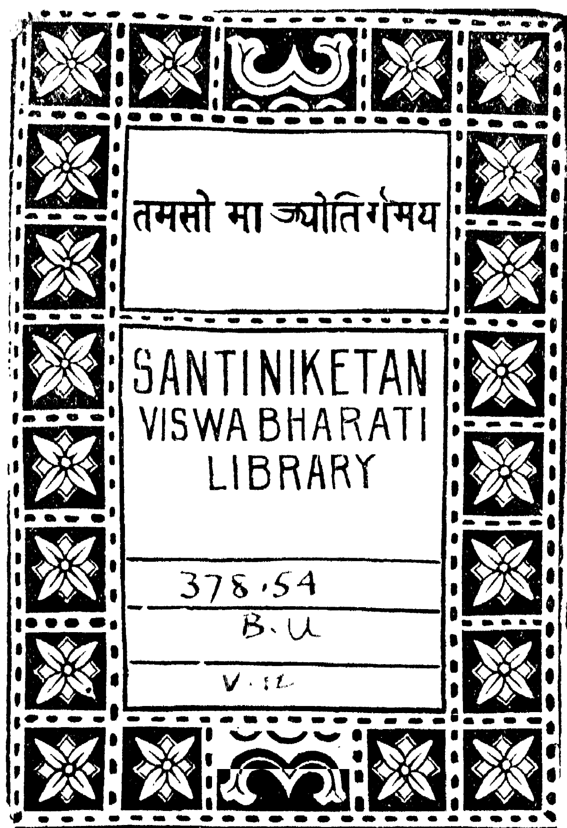


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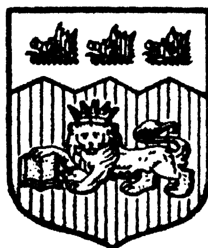


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THE ORIGINS OF CIVILIZATION IN EGYPT

By

S. N. CHAKRAVARTI, M.A.,

Prince of Wales Museum of Western India, Bombay

THE historical period in Egypt begins at the point where the kingdoms of the North and South, that is Lower and Upper Egypt, or the Nile Delta and Valley, were united by the first Pharaoh, traditionally called Mena, the Menes of the Greeks, as we know from king-lists, primarily the compilation in Greek by Manetho,[1] an Egyptian priest, in the reign of Ptolemy II Philadelphus (283-247 B.C.) and then the two chief hieroglyphic lists, the Royal Papyrus of Turin[2] written about 1300 B.C., and the Palermo Stone[3] inscribed about 2700 B.C. It is divided by Manetho into dynasties. According to modern historians Egyptian history falls into three main periods, separated from each other by two periods of decline ; the Old Kingdom corresponds to Manetho's Dynasties III-VI, the Middle to XI and XII, and the New to XVIII and XIX. The period of the first two dynasties is called early dynastic or archaic Egyptian.

Mena, who according to Manetho was the first dynastic king of Egypt, appears to have been a composite personage of tradition, representing the first three kings of the 1st Dynasty, namely, "the Scorpion," Narmer, and Aha Mena. Of "the Scorpion," so named from the hieroglyphic which represents him, we possess a carved mace-head from Hierakonpoli- (Plate VII, a). It shows the king wearing the Northern crown and directs ing the construction of dikes and canals probably in Northern Egypt.[4]

1 Manetho's work gives a complete list of the kings of Egypt from Mena, who was preceded by the gods, down to the Ptolemies. It gives the years, months and days of the reign of every king. The kings are divided into dynasties. Thirty dynasties ruled successively over Egypt during the period beginning with Mena and ending with the conquest of the country by Alexander the Great. Manetho's work is lost, and we know it in fragmentary citations by Flavius Josephus (first century A.D.), Julius Africanus (third century A.D.), and Eusebius (fourth century A.D.). Moret, *The Nile and Egyptian Civilization*, pp. 3 ff.

2 The Royal Papyrus preserved in the Turin Museum was written under Rameses II of the XIXth Dynasty. It is sadly mutilated. It begins with the gods who reigned on earth, and makes the "Servants of Horus" the immediate predecessors of Mena. It gives, in addition to the years, the months and days of the king's reign. Moret, *The Nile and Egyptian Civilization*, pp. 18-19.

3 This fragment of Annals, inscribed on a slab of amphibolic diorite and preserved in the Museum of Palermo, was probably drafted in the reign of Neuserra, a king of the Vth Dynasty. Five more fragments were found later. The Palermo Stone gives lists of the kings of the first five dynasties. It records the reigns of kings of Upper Egypt and the reigns of kings of Lower Egypt even prior to the 1st Dynasty. In the case of some later kings it gives the years of their reigns. Moret, *The Nile and Egyptian Civilization*, pp. 17-18 ; Childe, *New Light on the Most Ancient East*, 1935, p. 7 ; and Petrie, *The Making of Egypt*, p. 98.

4 A fuller description of the mace-head of "the Scorpion" is given by Rostovtzeff, *A History of the Ancient World*, Vol. I, p. 46.

Narmer succeeded "the Scorpion." Of the monuments of Narmer's reign the most important is a slate palette from Hierakonpolis (Plate VII, b-c). On one side of the palette Narmar is represented wearing the Northern crown and smiting a Northerner with his mace. On its other side he wears the Southern crown and inspects a heap of decapitated bodies of Northerners.[5] There is a tomb of Aha Mena at Abydos. Another tomb of this king exists at Naqada. One of the tombs is no doubt Aha Mena's personal tomb and the other that of his *ka* or soul.[6]

The king-lists give us also some information on the predynastic period. The Palermo Stone records the reigns of kings of Lower Egypt and the reigns of kings of Upper Egypt even prior to the Ist Dynasty. Mena, who was almost certainly a king of Upper Egypt, united both kingdoms under his sway and established the Ist Dynasty. But before him there had been according to Professor J. H. Breasted an older unification[7]; the Turin Papyrus makes the "Servants of Horus" or *Shemsu-Hor* the immediate predecessors of Mena,[8] and Professor Kurt Sethe interprets the legend of the *Shemsu-Hor* as implying the conquest of Upper Egypt by the men of the Falcon clan whose first home was in the western Delta.[9]

Remains of the predynastic period come almost entirely from graves[10] that can be arranged in their relative chronological order in consequence of Sir Flinders Petrie's[11] fixing, at Diospolis Parva, of a chronological system based upon differences in pottery vessels and other associated objects. The wavy ledge that originally served as a handle for a certain type of pottery vessels was found to fade away gradually until it became a mere decorative wavy line. The chronological succession of the whole range of such pottery vessels was established, and its several phases were correlated with stages of variation in other associated objects. A numerical scale of the so-called sequence dates (S. D.) was worked out, with the result that the chronological order of any one grave relative to the rest can be defined in figures. The sequence dates were numbered from 30 to 80, leaving space for earlier and later discoveries. This system of sequence dating settles the succession of industrial remains in an approximation to the real order of events. But it cannot give the intervals of time separating one stage from its next neighbour. The beginning of the Ist Dynasty is assigned to S. D. 78. The predynastic period is divided into three stages : the early predynastic, S. D. 30-37 ; the middle predynastic, S. D. 38-63 ; and the late predynastic, S. D. 64-77. The early predynastic stage is best represented at El Amrah. Hence it is called Amratian. Similarly, the middle predynastic is named Gerzean from

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5 A fuller description of the palette of Narmer is given by Rostovtzeff, *A History of the Ancient World*, Vol. I, p. 30.

6 Baikie, *A History of Egypt*, Vol. I, pp. 72-73. The belief in an after-life led the Egyptians to preserve the body after death or, at a later time, to place in the tomb a life-like statue for the *ka* or soul to occupy.

7 See Childe, *New Light on the Most Ancient East*, 1935, p. 7, and note 3 to chapter I.

8 Moret, *The Nile and Egyptian Civilization*, p. 63.

9 Sethe's interpretation of the legend of the *Shemsu-Hor* as expounded by Moret, *The Nile and Egyptian Civilization*, pp. 103-109.

10 Traces of predynastic settlements have been found at Ballas, Abydos and Mahasna. But the remains are scanty. Our knowledge of predynastic Egypt rests practically entirely on the discoveries made in the graves. Baikie, *A History of Egypt*, Vol. I, p. 36.

11 Petrie, *Prehistoric Egypt*, pp. 3-4, and *The Making of Egypt*, pp. 8-9.

Gerzeh, and the name Semainean from Semaineh is given to the late predynastic. All three stages are known from Upper Egypt.

Before the predynastic period went the neolithic represented at Badari, Deir Tasa, the Fayum and Merimde. The pottery of the Badarian period has been found beneath that of the early predynastic and later periods, and the Tasian period appears to be more primitive than the Badarian. The sequence dates of the Badarian period are 21-29, while the Tasian is assigned to S. D. 20.

We now come to the absolute dating of these periods.[12] The rise of the XVIIIth Dynasty is placed with fair precision at 1580 B.C. But the date of the rise of the XIIth Dynasty is a matter of dispute. Breasted and others are for 2000 B.C. But if this date be accepted the period between the XIIth and XVIIIth Dynasties known by merely adding the reigns as given in later sources is to be reduced by assuming that the XIVth, XVth and XVIth Dynasties of Manetho must have been partly contemporary. Petrie, however, is not inclined to reduce the period so much, and places the rise of the XIIth Dynasty at 2584 B.C. and the rise of the Ist Dynasty at 4326 B.C. Breasted and others do not agree among themselves in estimating the time between the rise of the Ist Dynasty and the rise of the XIIth Dynasty, and give different dates to the rise of the Ist Dynasty. Thus we have Dr. H. R. Hall's date of 3500 B.C., Breasted's date of 3400 B.C., Professor E. Meyers' first date of 3315 B.C. and his revised date of 3197-8 B.C., and Professor Gordon Childe's date of 3000 B.C. Here 3400 B.C. has been adopted as a more or less agreed date for the rise of the Ist Dynasty.

The length of time assigned to the predynastic period by different authorities varies from 500 to 2000 years. But we agree with Mr. G. Brunton[13] in assuming a period of 1000 years for the whole predynastic period in consideration of the fact that development is slower in primitive times than in later ages. We place, therefore, the beginning of the predynastic period at 4500 B.C.

Petrie places the beginning of the Badarian period at 7471 B.C., while other authorities contend for a reduction of the date to 5000 B.C.[14] It seems reasonable to assume 500 years as the length of time during which the Badarians flourished. We incline, therefore, to take 5000 B.C. as the date for the beginning of the Badarian period.

But the dates given to the different periods are no better than guesswork, for all Egyptian dates prior to 1580 B.C., the date of the rise of the XVIIIth Dynasty, are matters of doubt and dispute. They are not to be taken as more than an indication of the relative chronological position of each period, and are given, as Brunton[15] rightly says, "to satisfy those who clamour for figures of some kind as an aid to memory."

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12 Regarding dates see Peake and Fleure, *Priests and Kings*, pp. 28-36; Childe, *New Light on the Most Ancient East*; 1935, notes 1 and 2 to chapter I; Baikie, *A History of Egypt*, Vol. I, pp. 34-35; and Petrie, *The Making of Egypt*, pp. 9, 80, 121, 142.

13 *Antiquity*, Vol. III, 1929, p. 460.

14 On the date of the Badarian period see Childe, *New Light on the Most Ancient East*, 1935, pp. 12-13; and Peake and Fleure, *Peasants and Potters*, pp. 58-61.

15 *Antiquity*, Vol. III, 1929, p. 460.

It seems certain from what has been written that the continuous history of Egyptian civilization begins from the neolithic period. But there has been found in Egypt a sequence of palæolithic cultures correlated with geological phenomena that compares well with that of Western Europe. Before, therefore, we begin the description of the continuous history of Egyptian civilization, a brief reference must be made to the palæolithic cultures found there.

Egypt, properly so called, consists of that portion of the Nile Valley which extends from south to north between the First Cataract at Assuan and the Mediterranean Sea (Plate I). It is bounded on the east and west by rocky hills of the Arabian and Libyan deserts. The Northern Sudan, or Nubia, is situated to the south of Egypt. Next to Nubia comes Somaliland, formerly known as Punt. During quaternary or pleistocene times the Delta, or Lower Egypt, above Cairo, was under water. The comparatively recent formation of the land is indicated by the fact that Lower Egypt has yielded no palæolithic remains. The Valley, or Upper Egypt, between Cairo and Assuan, on the contrary, was inhabited by palæolithic man, as we know from various discoveries of his implements made by Drs. K. S. Sandford and W. J. Arkell in the stony alluvia of the quaternary Nile, by Miss G. Caton-Thompson and Miss E. W. Gardener in the Kharga Oasis, and by M. A. Vignard in the Kom-Ombo region.[16]

A series of terraces near Thebes and between Luxor and Assuit was studied by Sandford and Arkell. The highest and oldest terrace, 150 feet above the present level of the Nile, yielded no human implements. The terrace at 100 feet contained Pre-Chellean, Chellean, Chelleo-Acheulean, and early Acheulean handaxes, and Clactonian flakes. Mammalian fossil remains, representing a middle pleistocene fauna, were found in this terrace. Acheulean handaxes occurred in the terrace at 30 feet, and Mousterian flakes in the terrace at 15 feet.

At Kharga Caton-Thompson found Acheulean handaxes in gravels underlying tufas of pleistocene period. No mammalian fossil remains were found in association with the industry. At the very lowest level of the tufas there were found in places Levalloisian flakes. Next, there was a level with Mousterian, or developed Levalloisian, industry, superimposed by another level with an industry called Aterian after the site of Bir-el-Ater in North Africa (the Magrab). The Aterian industry is derived from the Levalloisian-Mousterian complex. The lower Aterian is characterized by a tanged point, which is a Mousterian point with the butt trimmed down to a tang. The characteristic implement of the Upper Aterian is a laurel leaf-shaped point, flaked finely all over both faces and strongly recalling the Solutrean of Europe. Both tanged points and laurel leaves occurred in the Aterian of Kharga.

At Kom-Ombo Vignard found an industry, called by him Sebilian after the site of Sebil. Like the Aterian industry, the Sebilian is derived from the Levalloisian-Mousterian complex. In the Lower Sebilian Mousterian-like tools were more common than microliths, while in the

[16] For the palæolithic cultures of Egypt see Leakey, *Stone Age Africa*, pp. 114-120; and Pradenne, *Prehistory*, pp. 143-146.

Middle and Upper Sebilian microliths were dominant. The final stages of the Sebilian contained neither pottery nor polished stone.

In Egypt the connection of the mesolithic period with the neolithic is not well established. However, there have been discovered four neolithic cultures. They are the Tasian, the neolithic of the Fayum, the Merimdian and the Badarian.[17] The first three cultures look like different aspects of a single culture, and are more primitive than the last.

The first neolithic culture is named Tasian from the village of Deir Tasa in Middle Egypt where it was first known. The authors lived in a semi-nomadic state, as is suggested by the rarity and dispersal of the graves and the presence of Red Sea shells in them. That they knew agriculture is indicated by stone corn-grinders found in their graves. They fished with small hooks of shell or horn. No implements which can be definitely called weapons for hunting, such as mace-heads, have been found. But a triangular perforated stone, though found in a woman's grave, may have been used as the mace-head. Their mode of life appears to have been similar to that of the Hadendoa who lived last century as a pastoral people in the eastern desert but formed settlements for some months close to the flooded lands to sow millet seeds and reap them.

The Tasians used ground axes, either of hard white limestone or greyish green igneous rock. This is an indication that timber was abundant. We can imagine that large trees grew on what is now desert at the foot of the rocky hills which hem in the Valley of the Nile on the east and west.

The pottery is the distinctive product of the Tasians (Plate II, a). The pots, generally very rough, are grey-black in colour. The characteristic shapes are beakers with a flaring rim and burly bowls. The beakers are ornamented in zones, in imitation of basketry, with incised lines filled in with white.

The Tasians used woven cloth as a covering, as indicated by some faint traces of linen. The palettes of alabaster or limestone, rectangular and without any notches, found in their graves, indicate that the face and eyes were painted. Ornaments were worn, for perforated Red Sea shells, cylinder beads of bone or ivory, and a bangle of ivory have been found.

The dead were buried in the contracted attitude, though the pits were often wide and deep. The people were dolichocephalic, but had broad faces and square jaws unlike the Badarians.

The second neolithic culture has been discovered in the Fayum depression, the ancient shores of an extensive lake that was 200 feet above the surface of the present lake. That its authors were not semi-nomadic herdsmen seems to be attested by the discovery of a granary site consisting of 63 pits dug in the earth, of which 48 were, or had been, lined with straw matting (Plate II, c).

The Fayum people grew wheat and barley and flax. They reaped the cereals with saw-edged flint mounted on a straight wooden shaft

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[17] For the neolithic cultures of Egypt see Childe, *New Light on the Most Ancient East*, 1935, pp. 52-68; and Petrie, *The Making of Egypt*, pp. 3-14. See also Brunton's "The Beginnings of Egyptian Civilization" in *Antiquity*, Vol. III, 1929, pp. 456-467; and Caton-Thompson's "Explorations in the Northern Fayum" in *Antiquity*, Vol. I, 1927, pp. 326-340.

(Plate II, d), and stored them in silos. The cereals were ground on stone saddle-querns. Sheep or goats, swine and cattle were domesticated. The Fayum settlers also hunted and fished. They used arrow-heads and points of flint and mace-heads of tough stone, and points and harpoon-heads of bone. The arrow-heads are frequently with hollow bases. The points are leaf-shaped, and may have served as spears or knives. The mace-heads are disc-shaped and perforated. The bone points, which are cylindrical and sharpened at both ends, may have been used as arrow-heads. The bone harpoon-heads have barbs projecting from a cylindrical stem. They used also ground axes, either of flint or basalt, polished flint blades, and the side-blow flake of flint.

The pottery is dull red or grey-red in colour. The round-bottomed and straight-sided vessels, either large cooking pots or small cups and bowls, somewhat resemble the Tasian burly bowls. But the beaker is absent, whereas there are rectangular dishes with a rim characterized by four peaks at the corners and bowls with a low pedestal. Objects of basketry include dish covers and a boat-shaped basket.

Fragments of coarsely woven linen and limestone spindle whorls have been found. There are rectangular palettes of alabaster, disc-shaped beads made out of ostrich egg-shell and green microcline felspar, and perforated Red Sea shells.

The third neolithic culture has been found at Merimde on the western edge of the Delta. The Merimdians, as its authors are called, grew emmer wheat, which they reaped with sickles resembling those from the Fayum. They stored their grain in silos with a basket at the bottom, and not in straw-lined silos as in the Fayum. They domesticated the same animals, namely, swine,cattle, and sheep or goats, as in the Fayum. They were also hunters and fishers. They used pear-shaped or spheroidal stone mace-heads, hollow-based flint arrow-heads with straighter sides than in the Fayum, flint blades, round sling stones, and axe-heads like those from the Fayum. The flint blades retouched along both edges may have been used as knives or daggers. Their bone implements and tools comprised fish-hooks, harpoons, needles, bodkins, and chisel-shaped smoothing tools. Cooking was done in shallow hollows dug in the ground.

The pottery is generally dark-faced (Plate II, b). The forms include burly jars of the Tasian type, bowls with a pedestal like those from the Fayum, boat-shaped troughs, ladles, twin-vase, and vessels with lugs for prehension or suspension.

Spindle whorls occur. But no linen has been found. There are palettes for the preparation of cosmetics, ivory bangles, bone finger-ring, disc-shaped or cylindrical beads of bone and shell, and perforated miniature stone celts for use as amulets.

The Merimdians dwelt in houses, probably mud huts or windscreens of skins or matting, supported by wooden posts. Unlike the Tasians or Fayum people, they buried their dead among the dwellings. The skulls, though dolichocephalic, have a wide brain case as the Tasian.

The Badarians, so named from the Badari district of Middle Egypt where they were first recognized, were the cultural heirs of the Tasians.

They grew emmer wheat, and domesticated sheep and cattle. Hunting and fishing were also practised, as attested by flint arrow-heads, wooden throwing sticks, and hooks of shell. The arrow-heads are hollow-based or leaf-shaped. Their houses were like those of the Merimdians. Cooking was done in small hollows dug in the ground. But the Badarians do not seem to have remained in any one site for a long period, as we know from the shallow deposits of village rubbish, consisting of ash and charcoal, and containing sherds and flint flakes, and from the small and scattered groups of graves. The vast amount of charcoal found indicates that wood was abundant due to the climate then being wetter than at present.

The Badarians wore skin garments. They wore also linen garments, for remains of these have been found in their graves. But skin garments were used more frequently than linen ones. They painted their face and eyes with green malachite paste ground on rectangular stone palettes generally with concave or notched ends. They wore ivory combs headed by the figure of a bird in the hair and studs of pottery and green stone in the ears and nose. Red Sea shells, discs cut from ostrich egg-shell, and beads of glazed quartz or felspar, bone, ivory and copper were strung together as necklaces or girdles. An amulet of bone in the form of an antelope or a hippopotamus was sometimes hung on the necklace.

The pottery vessels found in graves are extraordinarily thin (Plate II, f). They are decorated with a series of finely rippled grooves produced by a blunt toothed comb. They exhibit a perfection of technique that is at no other time reached in Egyptian ceramics. The top and inside of the vessels are black, whereas the surface is brown or red. This is due to the vessels being fired mouth down. The principal shapes are bowls, often steep-sided and sometimes carinated. A globular flask has four handles on the belly, and a bowl has on the inside a more or less conventional design of a plant scratched.

There were in use vases of almost cylindrical form with overhanging rim, ground out of basalt, and also flasks, small cylindrical vases, and round or square ladles of ivory. The handles of the ladles generally end in the form of animals' heads.

The Badarian graves were plain holes, sometimes lined with matting. The dead were buried partly contracted and usually facing west. They were provided with pottery vessels, in front of or above the head, from which to eat and drink. Female figures, carved in ivory or moulded in clay, occur in some graves (Plate II, e). These probably represent the Mother Goddess or the Fertility Goddess.

The Badarians were a short and slender race, and had small skulls of the dolichocephalic type. They do not seem to have belonged to the same racial stock as the Tasians ; they have some affinity to the negroid type but bear the closest resemblance to the Dravidians of South India or Veddahs of Ceylon.

Petrie thinks that the Badarians came from the Caucasus. They grew emmer wheat, and this has been connected with the story of Osiris, who taught the Egyptians agriculture. The belief in a vegetation deity is even now strong in the Caucasus. Further, various place names in the Egyptian spells of the Book of the Dead have been identified with places

in the Caucasus. As for example, Akret is the capital of the Kingdom of Osiris, and the Greek name of the capital of the Caucasus is Ekretike. But no Badarian element is known in the Caucasus. On the other hand analogies to the Badarian culture can be cited from Nubia down to historic times (pottery, for instance). Brunton and other authorities locate, therefore, the original home of the Badarians in Nubia. Again, the fact that the Badarians did not use the tabular flint from the local deposits has led Caton-Thompson to support the Nubian theory. In any case the connection is certain between the Badarians, their cultural ancestors the Tasians, and their physical and cultural descendants the Amratians. A number of cemeteries and a few settlements of the Amratians have been found in Upper Egypt and Nubia.

The Amratians[18] had lost the negroid or South Indian traits that characterized the Badarians. They were short, slender and lithe, and with small skulls of the dolichocephalic type. The present-day Bejas of Eastern Sudan resemble them. As we shall see later, the absence of negroid or South Indian traits in the Amratians seems to be due to an infusion of Libyan blood in them.

Figures of clay or ivory throw additional light on the appearance of the Amratians. There are two types of figures, *viz.*, the beardless and the steatopygous. According to Petrie the steatopygous figures, which are of women only, represent "the victims of slave raids from a neighbouring region, and not a permanent population in Egypt," while the beardless figures of S. D. 31-34 are of the Amratians (Plate III, a).

The Amratians used copper for small tools, such as pins with looped head and harpoons. But the rest of their implements and tools were of bone or stone. Their flint tools included sickle-teeth, disc-scrapers, scrapers for use as razors, comma-shaped knives (Plate VI, a, 83 and 85), U-based spear-heads, and concave-based or tanged arrow-heads. The mace-head was a sharp-edged disc of tough stone. No stone axes or adzes were used. Their bone harpoons were of rather flattened shape.

The graves of S. D. 30 contain red ware with a black top and polished red ware. The black-topped ware seems to be derived from the Badarian. But it lacks the finely rippled grooves of the Badarian pottery vessels for funerary use. In S. D. 31 the black-topped ware is found associated with another ware, called white cross-lined. The new ware lasts till S. D. 34. It is a red fabric ornamented in dull white paint with basketry patterns and representations of men, animals, plants and other objects (Plate IV, b-c). The principal shapes are the flasks, carinated bowls, goblets on a low pedestal, twin vases and lank tumblers. Another type of ware is the black incised. It is found principally in Nubia, and occurs though never plentifully, throughout the predynastic period. That like the Tasian beakers the black incised ware was inspired by basketry models appears to be attested by its shape and ornamentation. Some Nubian vases imitate, however, a gourd in a straw sling.

Stone vessels, principally of alabaster and basalt, were in use. The forms are ovoid beakers on a pedestal with two lugs just under the rim

18 For the Amratian culture see Childe, *New Light on the Most Ancient East*, 1935, pp. 69-84; and Petrie, *The Making of Egypt*, pp. 15-30, and *Prehistoric Egypt*, pp. 14-16, 47-48.

and cylindrical jars with slightly convex sides and bevelled rims. Vases made out of ostrich shell or ivory were also in use.

The Amratians painted their eyes with green malachite ground on rhomboidal or animal-shaped slate palettes. They wore ivory pins and combs in the hair. Pins with a little bird carved on the top are more frequent than pins with crossing lines or plain pins. The combs are long-toothed (Plate V, c). They have commonly animal figures on them though they are sometimes plain. Ostrich-shell discs, carnelian, steatite, quartz, calcite, felspar, garnet, or green-glazed beads, and marine shells or coral were strung together as necklaces. Amulets of shell, ivory and bone, representing animals, birds or fishes, were attached to the necklaces. The bracelets were made of shell, ivory or tortoise-shell.

The Amratians dwelt in round huts. They buried their dead doubled up in shallow oval pits, and liberally provided them with tools and implements, ornaments and food.

It still remains to decide whence the Amratians came. Now, the scenes painted on the white cross-lined ware or incised on the black-topped pottery agree in style with the cave paintings of the neolithic period from the Owenat Oasis of the Libyan desert.[19] Thus it seems probable that the Libyan hunters modified the Badarian stock and culture, and brought in the Amratian culture.[20]

The Gerzeans were bearded, and had a long face, and a narrow and straight nose, as we know from the ivory figures of S. D. 38-47 (Plate III, b). A model house found at El Amrah shows that they dwelt in houses of wattle and daub, which were roughly rectangular and had a wood-framed doorway on one long side.

The Gerzean culture[21] seems superior to the Amratian by its richness, and differs from it by radical changes of fashion in weapons, pottery, and ornaments.

Among stone weapons the pear-shaped maces of white stone ousted the discoid type, the scimitar-shaped knives (Plate VI, a, 84) took the place of the comma-shaped ones, the V-based spear heads (Plate IV, e, 1) replaced the U-based type; rhomboidal daggers appeared (Plate IV, e, 2), and concave-based arrow-heads ceased. The flint working was much refined by the wonderful serial flaking which began soon after S.D. 40 and reached its acme between S.D. 55-66 (Plate IV, f; Plate VI, a, 82 and 86). The use of copper increased ; daggers, harpoons, flat chisels and adzes (Plate V, d, 1-2), hooked knives, razors, pins, needles and tweezers of that material have been found. But with the exception of a dagger with a deep mid-rib (Plate V, d, 3) from Naqada, of S.D. 63, none of the implements are definitely metallic types. The earliest copper daggers, dated to about S.D. 50, are flat and triangular (Plate V, b). The

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19 The paintings were discovered by Count Almassy. Leakey, *Stone Age Africa*, p. 159.

20 On Libyan elements in the Amratian culture see Childe, *New Light on the Most Ancient East*, 1935, pp. 83-84.

21 For the Gerzean culture see Childe, *New Light on the Most Ancient East*, 1935, pp. 85-106 ; and Petrie, *The Making of Egypt*, pp. 31-54, and *Prehistoric Egypt*, pp. 16-22, 48-49.

method of hafting of these copper daggers is found in Egypt at all later dates; the triangular blade is enfolded on both sides by crescent-shaped arms projecting from the hilt, and the whole hilt is riveted upon the blade.

The black-topped and polished red wares continued in use. But the white cross-lined pottery entirely disappeared. A new ware, called decorated pottery, appeared (Plate IV, d). It is buff-coloured, and painted with patterns in brownish red. The forms are clearly imitation of stone models. The designs on older pots consist of spirals, indicating rush-work covers in which the stone vases are carried for protection, or mottling, imitating coarse-grained stone. On later pots, after S. D. 45, plants, animals and ships are depicted. But while the representations on the white cross-lined pottery are naturalistic, those on the decorated pottery are stylized. There were also jars with wavy handles (Plate IV, a), rough pots, spouted jars and theriomorphic vessels of clay or stone. The wavy-handled jars, whose type gradually changed, furnished Petrie with the first means of his sequence dating.

Slate palettes in the form of animals continued in use. But the rhombic slate palette went out of fashion. The long-toothed ivory combs (Plate V, c) were replaced by the short-toothed ones (Plate V, a).

There is good reason for believing that Upper Egypt owed the Gerzean culture to Lower Egypt. Among the designs on decorated pots have been found many oared boats, most of which bear, as Mr. P. E. Newberry has shown, signs of ports situated on the Western Delta. It seems likely that the extension of the culture and power of Lower Egypt to Upper Egypt, at S. D. 46 when boat vases are abundant, reflects the conquest of Upper Egypt by Lower Egypt implied in the legend of the *Shemsu-Hor* as interpreted by Sethe. It seems likely too, that the calendar and writing of Lower Egypt were introduced into Upper Egypt at this time.

The Egyptian calendar[22] was at first based on the lunar year. Accordingly, the year consisted of twelve months of thirty days each. But owing to the regular summer rise of the Nile, it became necessary to have a solar year in order that agricultural operations might be put in hand in due time. At a very early date, which is fixed at 4236 B.C., five intercalary days were added to each year, thus reconciling the lunar calendar with the solar year. The beginning of the inundation of the Nile coincided with the appearance of Sothis (Sirius) on the horizon just before sunrise. This heliacal rising of Sothis, which occurred on the first day of the month of Thoth, marked the beginning of the calendar year. But the Egyptian year fell short of the true solar year nearly by a quarter of a day for every year that passed. It was once in 1461 years that the heliacal rising of Sothis coincided with the first day of the calendar year. This period is called by the Greek and Roman astronomers a "Sothic cycle," and Censorinus, who wrote his work *De Die Natali* in 238 A.D., says that a Sothic year began in A.D. 139. The Egyptians knew that Sothis took 365¼ days to return to its old place on the horizon. Inscriptions tell us that the heliacal rising of Sothis took place on the 28th day of the month of Epiphi in the reign of Thothmes III, on the 9th Epiphi in the ninth year of Amenhotep I, and on the 16th Pharmuthi

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22 On the introduction of the Egyptian calendar see Moret, *The Nile and Egyptian Civilization*, pp. 20-22, 105; Peake and Fleure, *Peasants and Potters*, p. 72, and *Priests and Kings*, pp. 28-34; and Childe, *New Light on the Most Ancient East*, 1935, pp. 5-7.

in the seventh year of Senusert III. Thothmes III and Amenhotep I belong to the XVIIIth Dynasty, and Senusert III to the XIIth Dynasty. The Sothic date for the beginning of the XVIIIth Dynasty is 1580 B.C., and that of the XIIth, 2000 B.C. Hence the previous cycles must have begun in 2776 and 4236 B.C., and the introduction of the calendar must be assigned to either of the two dates. The date 2776 B.C. is rejected, for the calendar was already established under the Pyramid builders of the IVth Dynasty that ruled, according to dead reckoning, that is according to reckoning based upon native annals, earlier than 2776 B.C. The date 4236 B.C. is, therefore, to be accepted for the introduction of the Sothic calendar.[23]

There were three forms of Egyptian writing,[24] which are called Hieroglyphic (*i.e.*, sacred engraved writing), Hieratic (*i.e.*, the priests' writing) and Demotic (*i.e.*, the people's writing). The oldest form is the Hieroglyphic, or purely pictorial. At a very early period the pictorial characters began to be modified and abbreviated, as they were found inconvenient to write quickly on papyrus. Thus a style of cursive writing called Hieratic was developed. The last form of Egyptian writing was called Demotic in which most of the pictures that had been preserved in the Hieratic characters disappeared. In the earliest stage each picture, or written sign which the Greeks called hieroglyph, corresponded to a definite object. Gradually, each picture, or ideogram, indicated not merely a definite object but also a definite word. Next, the conventionalized ideograms were put together to represent new words of which pictures could not be made, and each ideogram ceased to suggest the idea of the object pictured but represented only the syllable. Thus the syllabic stage of writing was evolved. Finally, the syllabic signs very early became alphabetic signs or letters. There were twenty-four signs, each representing a consonant sound. This is the earliest alphabetic hieroglyphic writing known. As the vowels were not written in this alphabet, picture signs which are called determinatives were added to the words to indicate their exact meanings. Before writing, a cylinder seal appears in S. D. 46. Cylinders with distinct hieroglyphs occur between S. D. 65 and 76, and the earliest historical sealings are of Narmer.

The calendar and writing were invented in Lower Egypt. That the astronomers of Lower Egypt invented the calendar is borne out by the fact that in the 30th degree of latitude, that is, in the territory of Memphis and Heliopolis, the beginning of the inundation of the Nile coincides with the helical rising of Sothis. In other words Sothis rises just before sunrise on the same day as the flood reaches the two cities. The invention of writing in Lower Egypt is attested by the fact that the hieroglyphic script used by the dynastic Egyptians contains signs among which plants and animals peculiar to the Delta are prominent.

Petrie thinks that the decorated pottery came from the eastern desert between the Nile and the Red Sea, the most likely region near to Egypt to have been the home of a people using stone vessels and their pottery

[23] The date 4241 B.C., formerly computed for the introduction of the Sothic calendar, has been found to be incorrect owing to a small error in the factors used. Breasted, *Ancient Times*, 2nd edition, p. 59, note 1.

[24] On the growth of the Egyptian writing see Petrie, *The Making of Egypt*, pp. 81-83; Childe, *New Light on the Most Ancient East*, 1935, pp. 8, 119; and Rostovtzeff, *A History of the Ancient World*, Vol. I, p. 53.

imitations. Its authors had been living in touch with Egypt throughout the Amratian period, as the occasional occurrence of their products shows, such as a decorated pot, or a stone vase, or a pear-shaped mace-head. And it is from the eastern desert, according to Petrie, that the pig-tailed men on the monuments of the early dynastic period came, for the stone vases they brought to the first Pharaohs as tribute are of the same type as those found in the graves of the Gerzean period. The wavy-handled jars, which appear at S.D. 40, however, are connected by Dr. H. Frankfort with North Syria.[25]

It is obvious that the new elements that characterized the Gerzean culture were introduced from Asia. But questions are to be asked : Were the new elements introduced through the intervention of intruders or through trade relations ? Whence did the intruders come ? And was their arrival a case of peaceful penetration or a case of armed struggle ? These questions we will answer after we have dealt with the Semainean culture.

We now come to the last of the predynastic periods in Upper Egypt, called Semainean.[26] During the Semainean period the black-topped pottery almost ceased, and the polished red ware became rarer. But the black incised remained in the form of a Nubian basket with a ledge round the top to hold a conical lid. The wavy handled pots became cylindrical in shape. The decorated pottery was in its final degradation ; streaks of parallel lines, rough comma-shaped dabs of colour, rough signs like the star, and very coarse figures of animals, namely, crocodiles, scorpions and serpents, appear instead of the stylized representations of plants, animals and ships. Both Amratian and Gerzean types of stone vases were found. Another type, which has very definite Mesopotamian analogies, consisted of twin vases. But the stone vases became monotonous, as they were made entirely of alabaster or basalt in place of the beautifully varied stones used in the Gerzean period. The use of copper continued to increase ; heavy square axes, round-headed adzes and a blade sharp at both ends appear. The earliest copper needle at S. D. 40 is with a looped head to catch the thread. After S. D. 40 needles pointed at each end and with a regular eye appear. The same form lasts up to S. D. 66. By S. D. 78 the needles are flat-headed, but the eye was made by cutting a crack along the stem. Flint tools, such as hoes, sickle-teeth, razor blades, disc-scrapers, chisel-ended blades, tanged or chisel-headed arrow-heads and large knives were used. But the flaking of flint deteriorated due to the increasing use of copper. Slate palettes continued to be used. But those in animal forms gradually became rarer, and the normal type after S. D. 70 was rectangular.

It will be seen from what has been written that the Semainean period had no generally distinctive culture. It was the age of unrest owing to the breaking up of the "First Union." The unrest, however, ended with the unification of Upper and Lower Egypt by Mena, the traditional founder of the First Egyptian Dynasty.

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[25] H. Frankfort, *Studies in Early Pottery of the Near East*, Vol. I, p. 104.

[26] For the Semainean culture see Petrie, *The Making of Egypt*, pp. 55-63, and *Prehistoric Egypt*, pp. 49-50.

Petrie[27] thinks that a new people, who had a falcon for their emblem and came by sea from Elam, began the dynastic series. They went down the Persian Gulf and settled in Punt, the modern Eritrea and Somaliland. Those who went up the Red Sea formed the dynastic invaders. They conquered the whole land, penetrating from Upper to Lower Egypt. The evidence is supplied by the carvings on an ivory knife-handle from Gebel-el-Arak (Plate VI, b) and by the paintings in red, black and white on the walls, plastered over with mud and washed over with yellow ochre, of a tomb at Hierakonpolis. The monuments in question are dated to about S. D. 63. On one side of the knife-handle is carved a figure of a hero subduing two lions. The hero wears "a thick coat and cap, and the lions have the thick hair under the whole body as a protection in snow." Thus Petrie suggests that the source of the group is a cold country which must have been the mountainous Elam and not the plains of Mesopotamia. On the other side of the handle are carved scenes of combats on land and sea between two peoples. The two scenes occur also in the tomb-painting. Both monuments depict a boat which is distinguished from the Nile papyrus barques by its tall prow and high stern.

But Petrie's theory of the invasion by the dynastic race from Elam is questionable. Hall[28] says, "The hero," depicted on the Gebel-el-Arak knife-handle, "looks more like a god of the desert between the Nile and the Red Sea than a Gilgamesh[29] or an Elamite—a god conceived by his worshippers under a form strongly influenced by Mesopotamian and Elamite ideas brought to the coast (of Magan ?) by sea and executed by a predynastic Egyptian artist." We shall see now that the hero belongs neither to the desert between the Nile and the Red Sea nor to Elam, but to a third centre which is most likely the Caucasus region. At Warka in Mesopotamia, a number of clay stoppers bearing the impression of cylinder-seals, belonging to the Uruk period, have been found. A commonly represented scene is that of a bearded hero with a bun of long hair at the back of his head and enclosed by a fillet. He wears a long garment fastened round the waist by a girdle, and carries a lance in his hand. Several clean shaven captives with their hands bound at their back crouch before him, while soldiers who are also clean shaven kill them.[30] Again, on a basalt stela of the Jemdet Nasr period from Warka (Plate VI, c) are depicted two hunters, bearded and dressed like the hero on the Uruk seals, fighting three lions.[31] Now, the hero on the knife-handle from Gebel-el-Arak is exactly the same in appearance and dress as the hero on the seals of the Uruk period and the hunters on the basalt stela of the Jemdet Nasr period. This fact would be better explained by the assumption of a common original homeland from which came the conquerors on the seals and stela from Warka and those on the knife-handle from Gebel-el-Arak and the painted tomb of Hierakonpolis.[32] Now, various place names mentioned in the Egyptian spells of the *Book*

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27 Petrie, *The Making of Egypt*, pp. 65-67, 77.

28 Hall's statement as amended by Childe, *New Light on the Most Ancient East*, 1935, p. 123.

29 Gilgamesh is the hero of the most important of all the ancient religious epics of Babylonia.

30 Carleton, *Buried Empires*, pp. 54-55; and Childe, *New Light on the Most Ancient East*, 1935, p. 156.

31 Carleton, *Buried Empires*, p. 62.

32 *Cf.* Carleton, *Buried Empires*, pp. 55-57.

of the Dead, which are usually called mythological, have been identified with places in the Caucasus.[33] According to Egyptian tradition Osiris was a great king, who taught the Egyptians agriculture and thus abolished cannibalism. The capital of the Kingdom of Osiris is Akret, and the Greek name of the capital is Ekretike. Akret agrees in name and position with the present Ararat mountain. Again, the Iaru river is the present Aras, the Kara river the present Kura, the Bakhu mountain the present Baku, the Andes mountain the present Andish, the Urmu lake the present Urmia, Tamanu the present Taman, On the present Oni, Astes the present Ashti, Aksi the present Aksu, Khalusa the present Chalasi, Restau the present Resht, and so on (Plate I).[34] Thus the connection between the Caucasus and Egypt seems certain. Petrie says, "At what point this mythology entered into Egyptian thought is not known. It cannot be before the use of corn in Egypt, brought there by Osiris, who converted the Egyptians from cannibalism. It might, however, be connected with a later movement somewhere before dynasty I—Badarian, Gerzean or Semainean, all Asiatic."[35] We do not feel disposed to admit the Asiatic provenance of the Badarian culture for reasons which have been already stated. But we agree that the Gerzean and Semainean cultures are Asiatic; while one branch of the new race from the Caucasus settled in Mesopotamia at the beginning of the Uruk period, another moved through Syria and Palestine into Lower Egypt at S. D. 38 when bearded figures in ivory begin to appear. That it was not without an armed struggle that the new-comers mastered Lower Egypt is indicated by the carvings on the ivory knife handle from Gebel-el-Arak and the paintings on a tomb of Hierakonpolis.

TABLE OF THE EARLY PERIODS IN EGYPT, MESOPOTAMIA AND INDIA

Date	Egypt	Mesopotamia	India
B. C. 3400	Early Dynastic	Early Dynastic	Mohen-jo-Daro
	Semainean	Jemdet Nasr	Amri
	Gerzean	Uruk	
4500	Amratian	Al'Ubaid	
5000	Badarian		
	Tasian	Neolithic settlement at Kish	Neolithic settlements at Sukkur and Rohri

NOTES.—Mohen-jo-Daro, though not yet historical for us, possesses a civilization fully equal to the early dynastic civilization of Egypt or Mesopotamia.

At Sukkur and Rohri stone tools have been found, which both in typology and in state of preservation resemble those at Mohen-jo-Daro. But geologically the industries of Sukkur and Rohri are to be given a greater age than the industry of Mohen-jo-Daro. See my article "The Origins of Civilization in Mesopotamia" in the *Journal of the University of Bombay,* Vol. XI, Part I, July 1942.

A bed of hearths with a stone industry containing many microliths of a massive character has been found on virgin soil at the bottom of the Kish *tell.* See A. V. De Pradenne, *Prehistory,* pp. 204-5.

[33] Petrie, *The Making of Egypt,* p. 81.

[34] Petrie, *The Making of Egypt,* pp. 81 and 14.

[35] Petrie, *The Making of Egypt,* p. 81.

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Acknowledgments

The objects illustrated in Plates II-VII are reproduced from the following publications :

No.	*Source*
II, a	Antiquity, Vol. III, 1929, fig. 2 on p. 466.
b	New Light on the Most Ancient East, 1935, fig. 17.
c	Antiquity, Vol. I, 1927, pl. V facing p. 334.
d	*Ibid.* pl. VI facing p. 336.
e	New Light on the Most Ancient East, 1935, pl. IV.
f	Antiquity, Vol. III, 1929, fig. I on p. 464.
III, a-b	The Making of Egypt, pl. XI.
IV, a	New Light on the Most Ancient East, 1935, pl. IX, b.
b	Prehistoric Egypt, pl. XV, 49.
c	*Ibid.*, pl. XVII, 68.
d	New Light on the Most Ancient East, 1935, fig. 33.
e	*Ibid.*, pl. IX, c.
f	*Ibid.*, pl. IX, d.
V, a	The Making of Egypt, pl. XV, 10-13.
b	New Light on the Most Ancient East, 1935, fig. 39.
c	The Making of Egypt, pl. XII, 26-28.
d	New Light on the Most Ancient East, 1935, fig. 37.
VI, a	New Light on the Most Ancient East, 1935, fig. 31.
b	The Making of Egypt, pl. XXXV.
c	Buried Empires, pl. facing p. 62.
VII, a	A History of the Ancient World, Vol. I, pl. IX, 2.
b-c	*Ibid.*, pl. IV, 1 and 3.

PLATE I

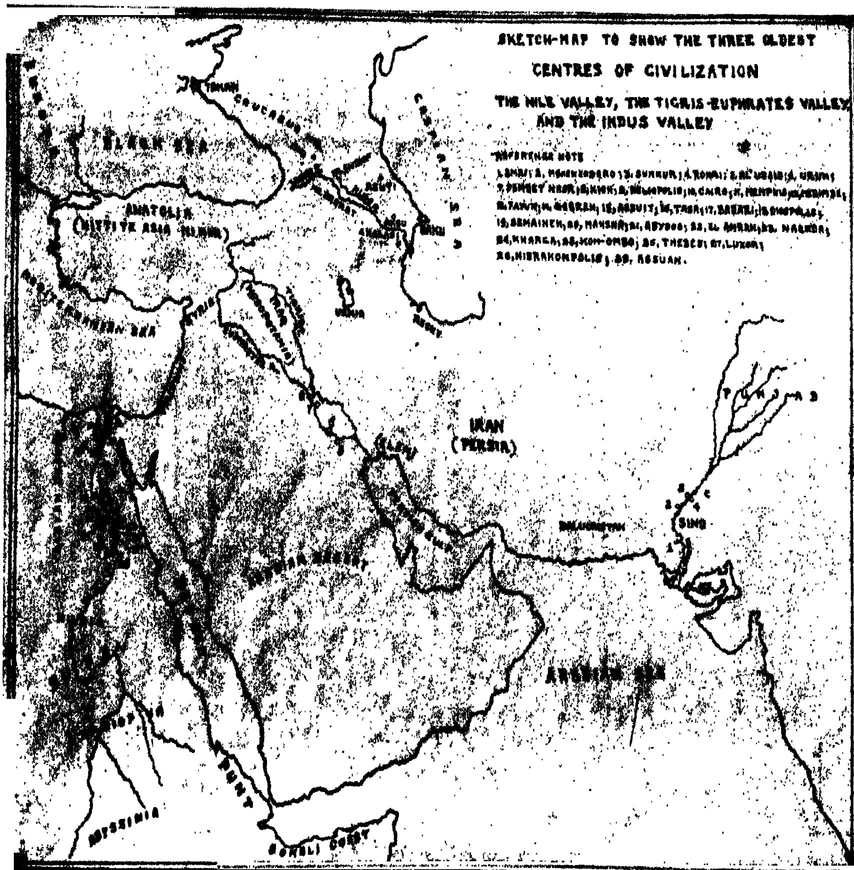
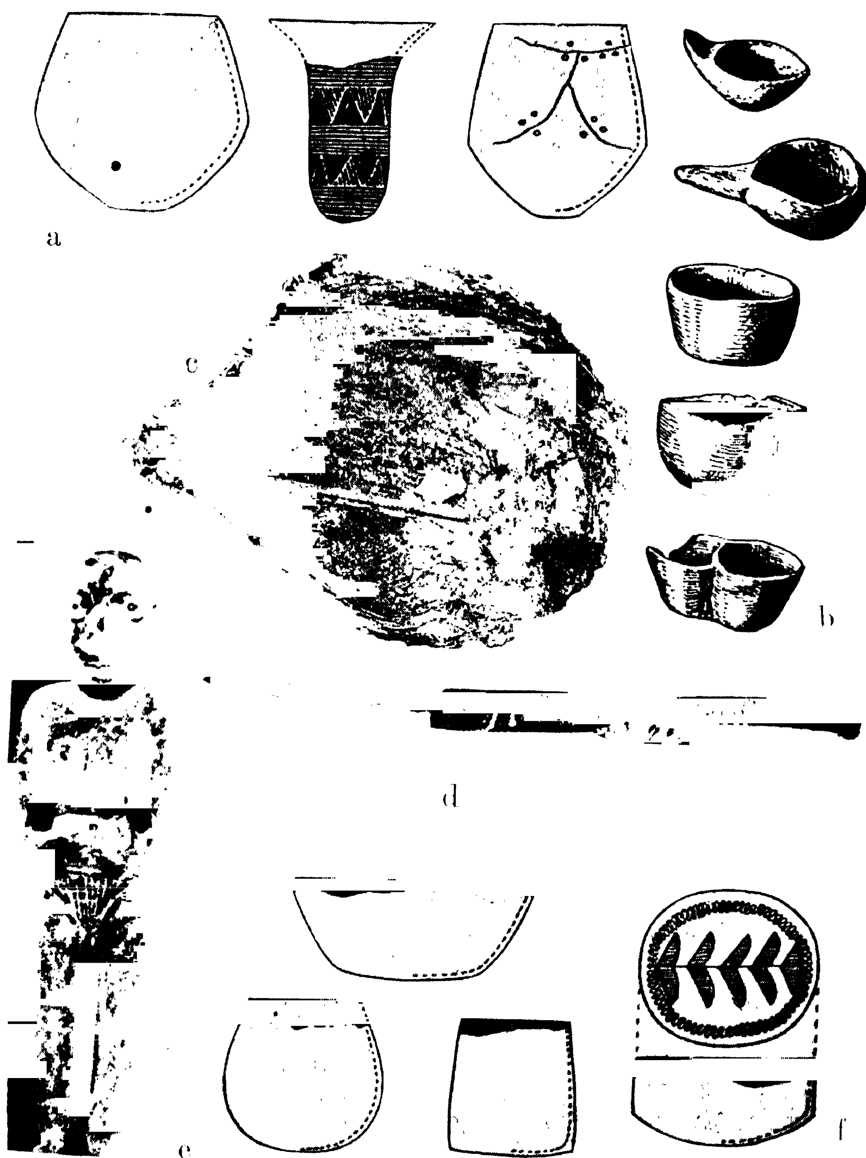
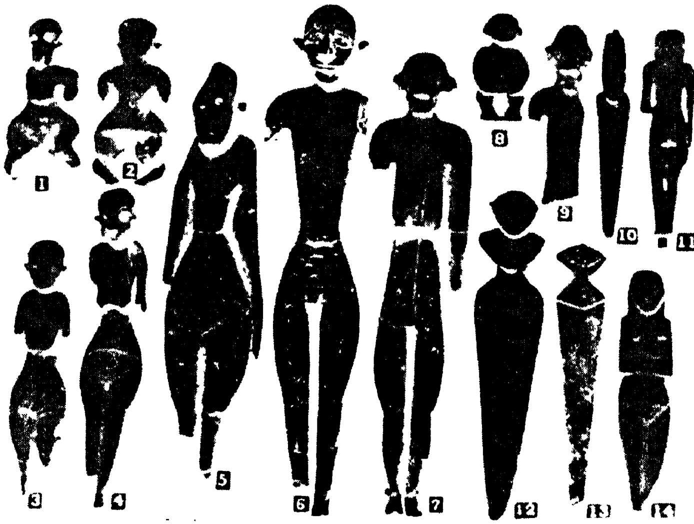

SKETCH-MAP TO SHOW THE THREE OLDEST
CENTRES OF CIVILIZATION
THE NILE VALLEY, THE TIGRIS-EUPHRATES VALLEY,
AND THE INDUS VALLEY
IRAN
(PERSIA)
SIND
SOMALI COAST

PLATE II



a—Tasian pots.
b—Merimdian ladles and pots.
c—Fayum straw-lined granary.
d—Fayum sickle with serrated flint blades.
e—Badarian ivory figure.
f—Badarian pots.

PLATE III

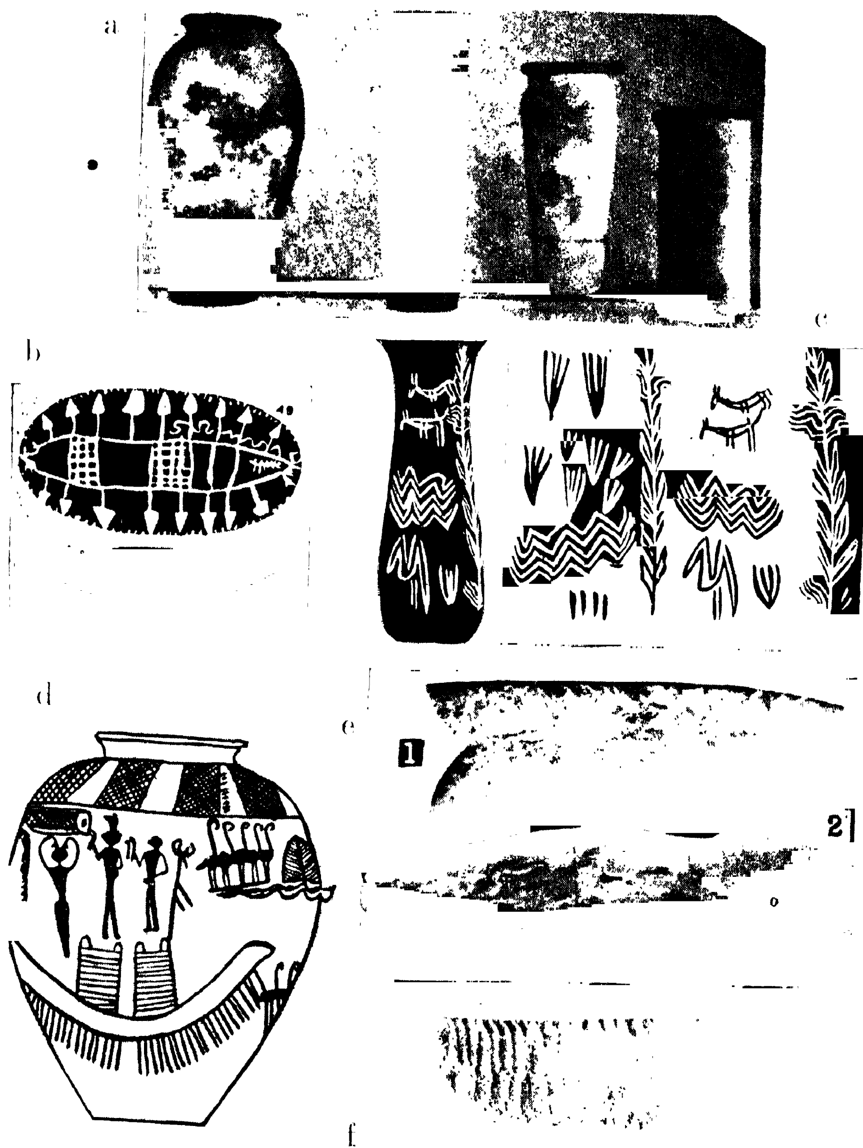




a— Amratian ivory figures

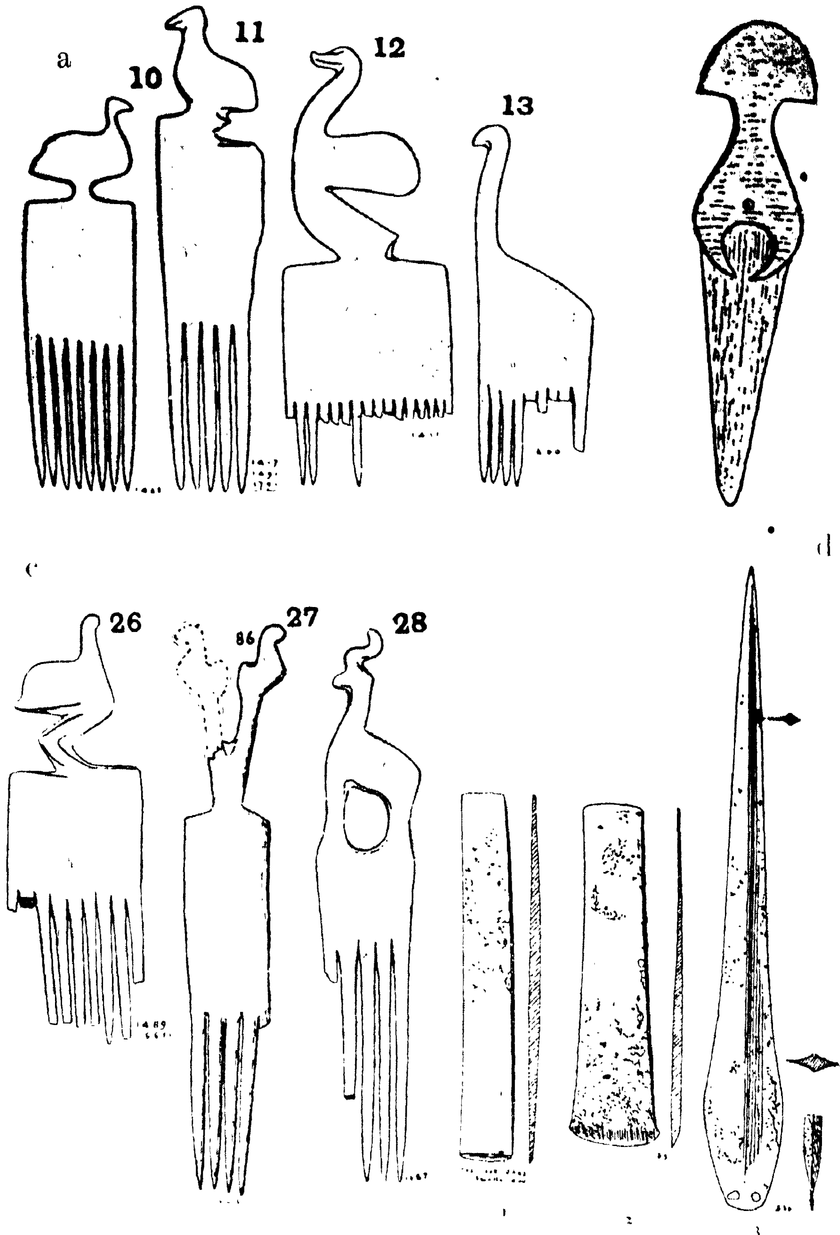
b —Gerzean ivory figures.

PLATE IV



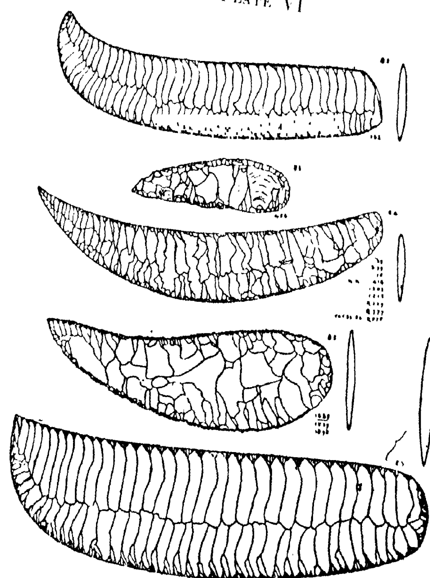
a—Gerzean wavy-handled jars.
b & c—Amratian white-lined pottery.
d—Gerzean decorated pot.
e—Gerzean V-based blade (1) and dagger of flint (2).
f—Gerzean flint knife showing serial flaking.

PLATE V



a—Gerzean short-toothed ivory combs.
b—Gerzean flat copper dagger.
c—Amratian long-toothed ivory combs.
d—Gerzean flat copper celts and dagger with a mid-rib.

PLATE VI





a —Flint knives: 83 and 85, Amratian; 84, Gerzean; 82 and 86, later Gerzean.
b—Ivory knife handle from Gebel-el-Arak.
c—Stela of the Jemdet Nasr period from Warka.

PLATE VII



a—Mace-head of "the Scorpion."
b & c—Palette of Narmer.

THE SURAT WEAVING INDUSTRY

By

M. C. MUNSHI,

Professor of Economics, M. T. B. College, Surat

I

IT is not generally realized that next to agriculture handloom weaving is the most important industry in India,[1] although its ancient glory has become quite proverbial. Indeed the glories of the Indian arts of cotton spinning and weaving have been sung by historians as early as 2,000 years ago—by Herodotus and Pliny—while traveller after traveller—Renandot, Chan-ju-Kua, Marco-Polo—has borne testimony to their excellence. It is now generally accepted that India was the birth place of cotton manufacture and long enjoyed a practical monopoly in the growth of cotton as well as the production of cotton fabrics. Even as late as 1600 A.D. this trade so impressed[2] the Portuguese that Pyrard quoted a saying: "Every one from the Cape of Good Hope to China, man and woman, is clothed from head to foot in the products of Indian looms." This might be an exaggeration—as W. H. Moreland is at pains to show[3]—but it could not be gainsaid that India had a monopoly of the market for cloth for many countries of the Indian Ocean.

Surat, particularly after the establishment of the Mussalman Empire, came to be called the "gate of Mecca" or "the city of the sun" with Rander nearby a very formidable rival which, however, declined after its destruction in 1512 and 1530 by the Portuguese. Thus Varthema concludes that Gujarat (chiefly Ahmedabad and Surat) supplied Persia, Tartary, Turkey, Barbary, Arabia, Ethiopia and other places with silk and cotton-stuffs.[4]

During the first century of the East India Company's trade it is well known that next to pepper, piecegoods was the most important article in demand. The annual average number of cloths ordered from Surat, Fort St. George and Hughly for the years 1658-64 was[5] :—

Surat	84½	thousand pieces
Fort	98	,,
Hughly	15	,,

[1] In 1939-40 with 1.5 million handlooms its production was 160 crores of yards of cloth, *i.e.*, 29 per cent. of the total cloth output.

[2] *cf.* also para quoted on p. 14, Bal Krishna: Commercial Relations between India and England.

[3] India at the Death of Akbar, p. 179, *et seq.*

[4] Moreland qualifies this statement by explaining that Varthema did not discriminate accurately between silk and cotton goods.

[5] Bal Krishna: Commercial Relations between India and England, pp. 139-140.

Surat easily topped this list; for during the next decade the quantity exported from this port was trebled (247,000 pieces during 1669—1672).[1] This prominence lasts almost till the end of the XVIII century during which Surat together with Bengal, East Coast and Nankeen (China), made up the East India Company's exports of cotton piece-goods from India.[2]

We need not pause to recall the chequered history of the opposition in England to the rising imports of Indian calicoes, muslins and chintzes, the stringent measures adopted in the 18th and early 19th centuries to stem and throw back this tide and the growth of the British cotton industry. But it would bear emphasis here that the cotton piece-goods which remained the most important article—next to spices—in the East India Company's trade for over a century (in fact the cloth trade between Surat and England reached its peak in 1682 with 1,436,000 pieces) suffered a decline, so that Surat lost its place to Coromandal Coast and Bengal after the depredations of the Maratha armies in Surat and the neighbouring districts. Thereafter Surat slowly dwindled as a cotton textiles exporting centre owing to a combination of causes political and economic.[3] But in spite of these vicissitudes or tribulations the city maintained its reputation for the excellence of its craftsmanship in weaving ; for the writer of the *Imperial Gazetteer* estimating, in 1901, 183,000 cotton weavers with 167,000 dependents in the Bombay Presidency in the districts of Poona, Sholapur, Dharwar and Belgaum could not withhold his tribute for "the highest point of excellence reached in Ahmedabad and Surat where some of the most skillful weavers in India are found."[4] Indeed we are told that these hand-made cotton-fabrics competed in the market with an immense import of machine-made goods and the author goes on to forecast that the few fabrics, for which the workers still held a reputation, would probably continue for many years to be in steady demand. Thus at the beginning of the present century we find that while there were 900 to 1000 looms for kinhabs in Surat, there were 1200 to 1500 looms for silk and cotton cloths with Kunbis, Khatris, Mussalmans, Bohras, Golas, Ghanchis and Kolis, being the principal communities engaged in the crafts.[5]

From this time onwards we would naturally hope for more systematic and complete data to be obtainable. Instead, we are forced to face a gloom such as the one which enveloped the whole economic life of Surat. Bombay did not merely eclipse Surat in trade and commerce or even denude it of its varied business talent ; the latter was in all respects submerged by the new forces that surrounded it. It has for all these years

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1 The Factory Records show the following towns that were important for the cloth trade of Surat. Nunsaree, Broach, Brodera, Nariad, Daboy, Dolka, Darboh, Darugam, Ahmedabad, Agra, Dungarrapura, Brahampore, Serrang, Cambaya.—*Ibid.*

2 See the Table from Select Committee Report, Handloom Industry in South India, by K. S. Venkatraman, p. 14.

3 In this long and eventful story it would suffice our purpose if we only referred to Major B. D. Basu's Ruin of Indian Trade and Industries, especially the extract on pp. 91-94 from the Diary of the Commercial Board at Surat about "the ordinary course of proceedings of the Company's commercial servants between the years 1796 and 1811."

4 Imperial Gazetteer, Vol. VIII, (Bombay Presidency), p. 324.

5 Bombay Gazetteer, wherein a separate chapter is devoted to the Arts and Crafts of Gujarat. See also Kavi Narmad's Gujarat Sarva-Sangraha, pp. 268-269.

excited the interest of the Department of Industries but precious little. To this aspect of the question we shall presently turn in the succeeding paragraphs. Let us, however, in the first place, understand the all-important fact about the survival of this industry in a city whose industrial fate appeared to be sealed by the new forces unleashed in the nineteenth century and the significance of that survival.

The general causes of the survival of the hand-loom industry are well-known and we need not linger long on these. It is common knowledge that because of the special types of cloth turned out by the handlooms, because of the surplus yarn produced and put on the market by the spinning mills, the vagaries of fashion and conservatism of some sections of the people, the handloom has held its own against the forces of large-scale production in India as in other countries like France, Germany and China. In fact the hand-loom may be said to possess a number of advantages over the mills. Besides the specialized type of demand to which it caters, it is comparatively immune from industrial strife and from the dictates of standardization. Further, after the advent of electricity the handicraft system has been reinvigorated by the decentralization of the motive power. In addition to all these there is one cause which needs special emphasis, for it will enable us to understand not a few of the problems that arise in the course of our study. It was very aptly pointed out long ago by Sir Alfred Chatterton : "The hand-loom weaver in India still survives to the present day because there is no alternative open to him, but in the struggle he has been reduced from prosperity to poverty and with the assistance of his women and children he is only able to earn a bare living."[1] These words are as true to-day as they were a generation ago when they were written. This feature is indeed the strength as well as the weakness of the handloom weaver as against the growing forces of competition.

Another question that arises from these considerations is the localization of the hand-loom industry in comparatively a few centres. There are 6 or 7 important centres in the Bombay Deccan, *viz.*, Sholapur, Malegaon, Ahmednagar, Ilkal, Dharmagaon, Hubli and Gadag. Rajbalbhat, Farasdanga, Chandannagar, Santipur, Darjeeling, Baburhat, Abdullapur, Tangail and Chaumuhani are the important hand-loom weaving centres in Bengal :[2] while in Madras—the most important province in respect of this handicraft—the districts of Cuddappa, Chingleput, Salem, Guntur, Coimbatore, Vizagpatam, Nellore, Bellary, Madras and North Arcot[3]—have 30 to 40 male weavers per 1000 principal male workers in all occupations.

The general causes of such localization are not far to seek. In the first place, in important commercial towns the presence of the capitalist itself brings the needy workers, in search of employment, together. This conglomeration then leads to economies in the preparatory processes especially in large centres where besides the weavers, other auxiliary workers can specialize in these processes. In effect these economies bring reduction of cost and increase in the output of the weaver. Being

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[1] Industrial Evolution of India, p. 213.

[2] See D. N. Ghose, Handloom Cotton Weaving Industry in Bengal, Department of Industries, Bengal, Bulletin No. 88.

[3] K. S. Venkatraman, Handloom Industry in South India, Table C, pp. 26-27,

in close touch with the market—it may be a weekly fair or Hat or Shandy or daily Gujari or the entrepot trade of that centre—the weaver or his employers are in living contact with the requirements of the consumers.[1]

To these may be added the early start in the race, the geographical position or the advantages of transport which act as a "spur to production and attract labour and capital into any area over which they are effective."[2] Over and above the interplay of these general causes we may refer to two factors that have particularly affected the establishment and fortunes of the hand-loom weaving industry at Surat which now remains the most important centre for this handicraft in Gujarat. During the heyday of Surat's prosperity in the 17th and 18th centuries, the principal features of the industry had become quite well marked. The simple technical structure of the handicraft and the almost complete absence of mechanical contrivances[3] naturally called forth a very high standard of manual skill and dexterity. These required a prolonged period of training which could then be organised only through a system of apprenticeship giving rise to a guild system for which Gujarat became so famous during this period. From such developments coupled with the steady demand for artistic products that came from the king's court and the gentry, we find the emergence of the Khatris as a community which has generation after generation regarded weaving as its ancestral art. This community has been to Surat what the Padmashalis have been to Sholapur and more ; for with their Panchas and Mahajans they maintained a closely-knit guild system and a high standard of craftsmanship.

The other fact—the one which has enabled the Surat Industry to weather many a storm of competition and to meet technical revolutions—is its adaptability to new conditions of production and demand. With the disappearance of the court-gentry and its demand for rich brocades and embroidered silks, it began catering to the demand of the new middle classes for other silks and then turned to silk-suitings and shirtings, finally to cotton coatings and shirtings. It passed on from the full-room-length pit loom to the Hattersleys and with the advent of electricity, from the Hattersleys to the small power-loom. When again it found that the cotton yarn of the required quality was difficult to obtain from the Indian mills[4] it turned to Japanese yarn and on the power-looms made the most of the imported mercerized yarn, fine cotton yarn and spun silk and silk-waste yarn.

When one bears all these general issues in mind and assesses the value of these peculiarities of the Surat industry one cannot but be dismayed at the paucity of reliable data that are obtainable. Undoubtedly we have to note that there has been in general an absence of statistical ma-

1 "The possibility of an industry to produce at a certain point at loss cost than elsewhere, to accomplish the entire productive and distributive processes of a certain industrial product cheaper at one place than at another."—Alfred Waber's Theory of the Location of Industry by Carl J. Fredrick, p. 18.

2 The Economics of Transport by M. R. Bonavia, p. 12.

3 Even today apart from the pit-looms there is a small Karkhana at Sayyedpura where on amazingly simple and cheap wooden frame looms costly silk sarees and embroidered silks are woven.

4 This was regarded by Mr. S. V. Telang as "the first and foremost difficulty" in his Report in 1928.

terial on this subject.[1] Indeed even the Bombay Economic and Industrial Survey Committee was constrained to observe that despite the investigators it was not possible to build up an estimate of the total number of looms in the Province.[2] But even if we keep these observations in mind, we cannot help feeling that the dearth of authoritative information in regard to the Surat weaving industry has been appalling. One is impelled to observe that the Department of Industries, too, seldom seems to have paid attention to the Surat problem with the sympathy it so obviously deserves. Even in the few cases where it has sought to supply information —as we shall presently see—this can hardly be relied on as clear or precise.

Let us, however, with the help of the material such as is available, continue our story of the Surat Industry. We have already adverted to the Bombay Gazetteer's summing up of the position at the beginning of the present century. During the next 15 years or so the main development was the displacement of the pit-looms by the Hattersley looms and there was a great increase in the latter during the last World War. We are told that the Karkhana system too had come into vogue at the outbreak of that War and the high-water-mark of the Hattersleys was reached between 1920 and 1922. If this oral information is to be relied on, the War—for obvious reasons—gave such a spurt to the industry that a few Karkhanas had power-looms installed which were run by electric or steam power generated separately at each Karkhana. We get a very inadequate picture of the industry even from the industrial census undertaken in 1921. The Census Report of the Bombay Presidency gives the following information :—

District	Total Workers and Dependents	Group 27: Cotton Spinning and Weaving		
		Actual Workers Males	Actual Workers Females	Dependents
Surat	14,897	4,285	2,915	7,697

We need not comment upon the insufficiency of this industrial census for our purposes beyond pointing out that although the number of looms was counted in a number of provinces and states at the time of this census of 1921, no figures were collected for Bombay, the United Provinces, the Central Provinces, Kashmere and Mysore;[3] and secondly that in Table XXII of the Bombay Report no weaving—mill or factory—for Surat is mentioned at all in 1921. (One Spinning and Weaving Mill, however, has been referred to.)

[1] The Tariff Board on the Textile Industry (1932) aptly remarked : "In our attempt to survey the present conditin of the (handloom) industry we have been greatly hampered by the absence of any authentic statistics and we have had to rely in the main on such information as the Local Governments could supply."—Report, para 159.

[2] Report, para 70. The Bombay Millowners' Association, therefore, in their written memorandum to the Handloom Industry Enquiry—Fact-Finding—Committee (1941) pleaded for a thorough investigation of the handloom industry as the first preliminary to any action.

[3] See also para 160 (pp. 156-157) of the Indian Tariff Board Report on the Textile Industry (1932).

We next come to Mr. S. V. Telang's Report on the Handloom Weaving Industry of the Bombay Presidency. This Senior Weaving Assistant of the Industries Department—who was "put on special duty to carry out this survey"—submitted his report in the middle of 1928 but it was published by the Department four years later.[1] Among the forty important weaving centres in the Bombay Presidency, Surat is reported to have 1800 throw-shuttle and 200 fly-shuttle looms in addition to 3,500 Hattersley looms. This centre is reported to produce kinkhawbs, silk-shirtings, coatings, silk-sarees, lungis and pitambers and to have a daily production of Rs. 15,000 in value. From the information we were able to gather, it is difficult to accept the figure of 3,500 Hattersleys in 1928. We have already adverted to the introduction of power-looms. After the advent of electricity for lighting purposes in the town in 1922 it began to be used, first by the gold-thread and then by the weaving industry.

Before the Telang Report was published a very creditable effort on a non-official basis was made by Mr. R. C. Surkatha as the Organiser of the Gujarat Art Exhibition held in Surat in 1929. Mr. Surkatha—with characteristic enthusiasm and industry—attempted, even within the limited period, to complete a directory of all the artisans of the city engaged in the various crafts. Perhaps this was the first endeavour made to obtain first hand information about the different handicrafts of Surat.[2] Not only is this directory a classified inventory of the names of the weavers arranged according to the different wards of the city, but it is further classified into the different branches of weaving, *viz.*, Kinkhawbs, Benaresi Ambars, Silk, Cotton, Mashru, Elaicha, Khans, etc. The total number of all these weavers is 2,095 inclusive of the Karkhanas. The avowed object of this effort, however, is too restricted to be of great use for our purposes.

The 1931 census, as is well known, did not continue the industrial census undertaken in 1921, but the census operations included the collection of some data as regards occupational distribution of the population. In statement XXII of the Bombay Report showing details of each kind of factories working in 1931 and the average number employed therein, mentions only 10 Textile Factories in the Surat District with 1,029 persons employed; while the next table shows 19 perennial factories and 33 seasonal factories in the district! More interesting than this effort is the attempt made in this Report to show the number of looms at important centres in the Presidency and their daily out-turns. But this information is very largely a repetition of the Telang Report.[3] In the case of Surat (the city), the Report reproduces the 1928 figures cited by Mr. Telang, *viz.*, a total of 5,500 looms with a daily out-turn of Rs. 15,000 in value and the same kinds of cloth as are mentioned by Mr. Telang.[4]

In about this period the Department of Industries published another "Report on the Arts and Crafts of the Bombay Presidency" by Mr. G. P.

[1] It is interesting to note that this 20 page brochure has been banked upon time after time—even the Census of 1931 Report practically borrows wholesale from it and the Department has only recently called it a "comprehensive survey!"

[2] See Gujarat Art Exhibition Directory of Surat Artisans published (in Gujarati) by the Exhibition Committee in 1929.

[3] Bombay Presidency Census Report (1931), General Report, p. 264.

[4] *Ibid*, p. 265.

Fernandez. This Assistant Curator of the Art Section of the Prince of Wales Museum first submitted his report in the end of 1927 and later submitted an abridged report in 1930. We are informed by the Director of Industries that this latter was "checked and corrected" by his Department and it could, therefore, be published only in the middle of 1931. In a sympathetic survey Mr. Fernandez bemoans the lot of the poor workmen who "may be seen seated at the loom the whole day long weaving a fabric little knowing how far and where it will travel or what fashionable halls it will decorate or which prince or nobleman it will clothe." He reports that so far as working classes are concerned Surat is a very poor district and the earnings from the loom are often insufficient to keep the wolf away from the door.[1] In fact he feels that if those conditions continued, the crafts fifty years thence would become, like the Dacca muslins, a matter of history. The reporter had to concentrate on the artistic side of the craft and so beyond giving a few specimens of the Kinkhawb, Jari-Dupatta, Sari Borders, etc., he rests content with mentioning that there were 10,000 persons employed in hand-weaving at Surat.

The avowed object of the survey was to examine the condition of those hand-loom weavers who were engaged in brocade and silk-weaving only, and we need not, therefore, linger on it. We may note, however, that about 12 to 15 years ago there were 10,000 persons engaged in this art-weaving and we find that the gloomy forebodings of Mr. Fernandez have been borne out by the passage of time.

A more systematic survey was attempted by the Surat District Co-operative Institute in connection with the investigations of the Bombay Banking Enquiry Committee, especially as regards the chief cottage industries of Surat city, in order to visualize the problem of the finance of these industries. A band of investigators was organised under the direction of Professor H. L. Kaji of the Sydenham College, Bombay, and the industries investigated were Gold and Silver Thread, Silk Gaji and Carving Industries. Two matters, however, have to be borne in mind in examining the findings of this exceedingly interesting enquiry. As has been pointed out by Prof. Kaji in his introduction to the "Notes on Gold and Silver Thread, Silk Gaji and Carving Industries of Surat,"[2] (1) the time within which the task was accomplished was very short—about a fortnight in the October vacation with Divali holidays intervening—and (2) so far as we are concerned the inquiry was limited to only one branch of silk-weaving, *viz.*, Gaji—which has long been a speciality of the Surat industry.

Despite these handicaps, the investigators, we are assured by Prof. Kaji, "collected information which can be regarded as reliable."[3] In 1929 the silk-weaving industry, though on the decline, employed about 10,000 to 12,000 workers out of which (*a*) 100 families (300 workers) could be classified as independent artisans, (*b*) 8,000 to 9,000 workers as craftsmen possessing their own looms, but working on materials supplied to them by merchants, and (*c*) about 1,000 pure wage earners in the Kar-

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[1] See his Report, p. 51.

[2] Published by the Central Education Board, Provincial Co-operative Institute, Bombay, 1929.

[3] It must be noted that the investigations were undertaken with the help of an influential committee of local co-operators.

khanas. The net earnings of the first came to Rs. 50 to Rs. 80 per mensem ; those of the second varied from Rs. 15 to Rs. 22-8-0 p.m. ; while those of the last were estimated at Annas 12 to Rs. 1-8-0 per diem. The margin of profit for the Karkhanadars ranged from 2 to 5 per cent.

Coming to the Gaji branch itself, they point out that "machine looms" (Hattersleys) were introduced in Surat in the first decade of the present century. They also refer to the difficulties that attended this introduction. The workers who had learnt to work on the new looms had to operate their looms behind closed doors. The workers' opposition to the new loom, too, is equally understandable for whereas with the pit-loom a piece of 60 to 65 yards that could be finished in 25 to 30 days fetched Rs. 50 to 70[1] (*i.e.*, Rs. 2 to Rs. 2-8-0 per diem), with the new loom with about 4½ times the output the wages fell to Rs. 30 to Rs. 40.

We also find a reference in this report to another factor in the growth of this industry that has been adverted to. Whereas before the last World War the silk-weaving industry depended almost entirely on Chinese silk yarn, after that war Japanese yarn became increasingly important. The report stressed another feature, *viz.*, that a large majority of the weavers worked on their looms but the materials were supplied by the merchants, which meant that the latter arranged for the raw-materials, the preparatory processes and on the return of the woven cloth for the finishing and sale of that cloth. In the silk-Gaji-weaving industry there were 200 to 300 weavers—out of whom 40 were women. It is also to be noted that two workers were reported to be required for each "machine" loom. The reasons might be that silk-Gaji-weaving requires great skill and care and that the weavers had not yet become quite familiar with the power-loom. Finally, the report notes that the Karkhanas very largely resorted to the use of steam or electric power for weaving. Thus by 1929, though there were a few Karkhanas which still used the Hattersleys, the power-loom had been extensively adopted even in the silk-Gaji-weaving at Surat.

It is indeed to be regretted that such an enquiry that dealt with the varied problems of the industry as the purchase of raw-materials, the sources of finance and the marketing of the products, or the status of workers, the profits of independent weavers, the output per worker and his wages, had to be so hurriedly carried out and that it was confined only to a part of an important branch of the weaving industry. It would also have added greatly to the importance of the enquiry if its method were stated. All the same it gives a very interesting picture of that part of the weaving industry some fourteen years ago.

We next come to the Bombay Economic and Industrial Survey Committee of 1938-40. In pursuance of its terms of reference the Committee naturally dwelt at length on the small scale industries of the province and made far-reaching recommendations about State policy with regard to its economic development—in fact the Committee itself has suggested that its report "should legitimately bear the title 'Small Industries Enquiry Committee Report' rather than the 'Bombay Economic and Industrial Survey Committee Report'."[2] The importance of this enquiry and its

1 See Notes, *Ibid*, pp. 11-13-15.

2 Report, p. 3.

report, therefore, for our purposes cannot be over-emphasized and we shall refer to their findings in the course of our study later also. Here we are concerned only with the collection of their data and their method of enquiry especially about the Surat Weaving Industry.

In the first place it has to be noted that the Committee's suggestion for an industrial census of the Province—even on a sample basis—was turned down for financial reasons. They had, therefore, to depend upon the information collected by the investigators of the five Divisions of the Province or the material supplied by the heads of Government Departments and revenue officials. The Committee begins by laying down the definition of cottage industries as "industries where no power is used and the manufacture is carried on in small Karkhanas where not more than 9 workers are employed."[1] By this definition by far the greater part of the Surat weaving industry of to-day was put outside the scope of their main recommendations. Some of their findings, however, though of a general character for the Province as a whole are of considerable interest and they must be briefly reviewed here.

The Committee point out that in what is considered the most industrial province of India, the population engaged in industrial pursuits appears to *have fallen* both absolutely and relatively to other occupations. This decline is largely accounted for by the fall in the number of workers in the cottage industries because, as they assert, the smaller factories outside the scope of the Factories Act, must have increased in number as also he paid up capital of joint stock companies registered in the Province. Not only have the cottage industries dwindled but the economic condition of these workers, too, has deteriorated considerably. This decline has taken place both among the whole-time cottage workers and those of the agricultural classes engaged in the subsidiary occupations like spinning and weaving.

Analysing the 1931 census figures, they conclude that the number of industrial workers in cottage and small scale industries would be 380,000. They did not find it possible to classify these figures still further into cottage and small-scale industries, though it might be generally inferred that the greater part of these must appertain to cottage workers. The Committee made an "elaborate attempt to obtain statistics of small scale industries which consist of workers not coming under the Factories Act," but they were only able to show that out of the 5,062 establishments using electric power in the Province, 2,735 were located in the city of Bombay and 1,566 in Surat (without giving estimate of the total number of these small concerns and the number of workers employed in them):[2]

Of still greater interest is their inference that 76,000 are employed in hand-spinning and hand-loom weaving and unregistered power-loom factories—in other words, 25 per cent. of the total engaged in the cotton textile industry of the Province. But they were not able to get any statis-

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[1] Report, p. 7, and compare the U. P. Industrial Finance Committee's definition: "A cottage industry is one which is carried on in or at his own home either on his own account or under the direction of his Karkhanadar;" or the U. P. Industrial Reorganisation Committee's definition: "Cottage industries are those in which work is done, generally speaking, in the homes of the artisans and occasionally in small factories run by small industrialists of the entrepreneur type, power-driven machinery being rarely used."

[2] See Report, p. 52.

tics for the smaller concerns (other than mills or hosiery works) having power-looms and weaving dhoties, sarees, shirtings, etc.[1] It is indeed to be regretted that in spite of their having called for information from Mamlatdars and other district officers they were able to get such unreliable details as 1,081 power-looms for the Surat district as a whole or the repetition of Mr. Telang's figures for 1928 as regards the distribution of the hand-looms in the various hand-loom centres of the Province—with a rather cryptic remark. "Surat of course comes in with its automatic looms."[2] It is also to be regretted that while the Committee were able to emphasize the rapid displacement of hand-looms by power-looms in Bhiwandi in the Thana district during the last ten years that followed the Telang Report,[3] the Committee lost a great opportunity of making a real advance upon that report as regards this latest tendency in the hand-loom industry.

This brief historical review will enable us in the first place to get some glimpses of the Surat weaving industry at various stages of its growth and secondly to observe that all these 'surveys' give but an inadequate picture of its structure or development. Indeed, as we have seen, the inadequacy has been the subject of complaint by the Tariff Board and such committees as the Bombay Economic and Industrial Survey Committee. Further added to insufficiency is the confusing nature of the material. Some of the reports do not properly indicate the types of looms beyond classifying them into throw-shuttle and fly-shuttle. Thus if we take a very recent estimate of the Department of Industries supplying information to the Handloom Industry Enquiry (Fact-Finding) Committee of 1941, it showed 4,500 looms for the Surat District but Surat is not mentioned at all in the list of 26 principal centres along with the number of looms therein.[4]

In order to study the present conditions of the weaving industry, in view of these considerations, the first requisite was a house to house survey that would include a census of looms and of the workers engaged in the industry. The difficulties of conducting such a survey can be easily imagined when we remember (*i*) the unorganised character of the industry ; (*ii*) the spreading out of the processes over different types of full time and part-time workers ; (*iii*) the domestic nature of the crafts ; (*iv*) the extreme conservatism (culminating sometimes in mistrust if not actual hostility) of even well-established Karkhanadars; and (*v*) their grave apprehension of some undesirable governmental action resulting from these investigations.

1 "No statistics are available of the number or other details of such concerns."—*Ibid*, p. 57.

2 *Ibid*, pp. 58-59.

3 "Bhiwandi is remarkable in that it was originally a hand-loom weaving centre, and during recent years it has witnessed a considerable supersession of the hand-loom by the power-loom, so much so that today the estimate is that there are 600 power-looms and not more than 300 hand-looms in this centre, as against nearly 3,000 hand-looms in 1928."—Report, Vol. II, (Thana District), p. 16.

4 The writer is indebted to the Commercial and Industrial Intelligence Officer of the Department of Industries, Bombay, for putting at his disposal the material collected by this Department in connection with the Thomas Committee. These statements are primarily intended to indicate the intricate problems the subject raises.

If we take a very interesting attempt made by the local Municipality at noting the occupational census of the city in 1934, we would get a further glimpse of the difficulties involved. The following figures summarise the result of this occupational census so far as the weaving industry is concerned :—

Occupation[1]	Hindus				Muslims				Jains				Others			
	As principal occupation		As working dependents		As principal occupation		As working dependents		As principal occupation		As working dependents		As principal occupation		As working dependents	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Total Class III Industry—Total Order 5 Textiles ..	5,785	675	1,043	1,018	2,138	120	340	265	88	5	6	16	22	10	..	37
Cotton Spinning and Weaving ..	3,014	419	393	440	982	63	171	132	8	..	2	..	17	1	..	..
Silk Spinning and Weaving ..	203	9	6	14	7	1	2	..	7	2	2	2	..	..	..	..
Dyeing, Bleaching, Printing, Preparation of Textiles ..	437	..	15	1	57	6	4	6	1	..	..	..	1	..	..	..

The variations in these estimates emphasize their conjectural character. Our main object, however, in using these and the other factual data is to indicate the broad trends of the industry.

[1] Acknowledgments are due to the office of the Surat Borough Municipality from whose records this table has been prepared.

An attempt was made after enlisting the support of the leading weavers and Karkhanadars[1] to obtain information first hand by personal investigation. A house to house enquiry was started and a detailed questionnaire was issued for the purpose. In order to meet the exigencies of the situation such as the shortage of paper the different parts of the industry were dealt with in the same questionnaire. It was divided into a number of sections (12) pertaining to the number, kinds and types (or size) of the looms, the cloth woven, the general conditions of the productive unit, the wages and the weavers' costs, the purchase of yarn and the preparatory processes, the capital and the selling organisation along with a few questions in between to ascertain what the worker would actually get.

As the work had to be carried out only in spare time (and in the holidays) it was decided to fill in the forms in two ways. For the purposes of the census answers only to a few leading questions were obtained from all establishments while typical outworkers were selected for more detailed study. The same combination of the census and the sample method was adopted for the Karkhanas. As can be seen from the foregoing historical survey, it was well-nigh impossible to check the results except by the rule of the thumb, that is by consulting the leading Karkhanadars or other leading men of the localities. In the case of the Karkhanas coming under the Factories Act, however, a check was possible and it was applied. The writer feels it his duty to record with gratitude the co-operation and support received from the above-mentioned gentlemen.[2]

Excluding the big mills of the city 643[3] places of work were visited which showed 4,108 looms. Out of these there were 3,645 power-looms, 325 Hattersleys and 138 pit-looms. An attempt was made to relate these figures with those actually working, but as the investigations were spread over a long period, the percentage of looms working to the totals was not found to be useful. Moreover, as we shall see later, for most of these places of work there is a slack season extending from 3 to 5 months, especially the monsoon-months during which many looms are forced to be idle or only partly-working. This important feature of the Surat weaving industry arises out of the fact that the preparatory processes, in particular sizing, cannot be undertaken regularly in wet weather. Hand sizing which still remains the dominant method, entails the spreading out of the yarn in the open—even in the streets outside the houses of the sizers—and this is, obviously, not feasible during the monsoon. This fact affects the economic position of the worker to an appreciable extent. Of this, however, more anon.

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1 An appeal under the signatures of these gentlemen was issued and shown to the craftsmen whenever needed.

2 Especially from Mr. Kanchanlal C. Kapadia (Secretary, the Surat Weaving Association), Mr. Dhirubhai J. Desai (of the Desai Silk Mills, Saggrampura), Mr. Bhanabhai (of Messrs. Atmaram Sanmukhram & Co.), Mr. Uttamram B. Chevli (of Begumpura), Dr. Amichand C. Shah (President of the Weaving Association), Mr. Shantilal (of the Parmar Weaving Factory), Mr. Prabhudas Ghariwalla (of Salabatpura) and Mr. R. C. Surkatha.

3 In addition to these we have included in our computations 6 Karkhanas which could not be visited owing to the recent outbreak of strikes in these factories. If these are included in this figure the total would be 649.

The classification of the looms as recorded in the different parts of the city is as under :—

Locality	Power-looms	Hattersleys	Pit-looms
Rustampura	185	....	..
Sagrampura	482	8	10
Gopipura and Limdachowk	325	27	12
Navapura and Indrapura	208	....	4
Salabatpura	1,138	279	25
Begumpura	533	....	..
Manchharpura and Mahidharpura ..	384	....	8
Sayyadpura	80	....	74
Scattered Areas	310	11	5
Total	3,645	325	138

Salabatpura is indeed the most important ward for the weaving industry and a walk round its streets will convince even a casual visitor that it is an area busy as a bee-hive. It is also the same ward in which the Momnas (a Muslim community) have concentrated with their 195 establishments a great part of which consists of one or two Hattersley looms in the house of Kathiawari Momnas. This community has still retained this type of loom, worked with their feet, whereas in other localities (except to a small extent in Gopipura where too there is a small cluster of Momnas) the power-loom has ousted the other types. This development raises issues of the gravest import to the whole organisation of the weaving industry of Surat such as the increase of output per loom, the use of staple fibre, the size of establishments, the entry of communities other than the Khatris and the Muslims, the shrinkage in the number of independent weavers, and the rise not only of outworkers but also the increase in the number of Karkhanas owned by men who are outworkers on contract, but who also act as employers of other weavers on the power-looms on piece-work.

As regards the pit-looms, it is necessary to add that they are somewhat difficult to detect, especially in the slack-season. Even in the busy one, the power-loom or the Hattersley cannot remain hidden ; while the silent but extremely inviting pit-loom may avoid the inquisitive gaze. On a second survey it may be necessary to revise the figures for the pit-looms slightly.[1] Sayyadpura is the most important area for this type of looms where the 'Benaresis' ply their craft in their own tenements day after day, patiently and noiselessly turning out only a couple of yards per day in the "busy season" of costly silks or silk and brocade or Ambers or the Elaicha or the Gaji.

When we turn to the distribution of the looms over the different parts of the city, in accordance with the size of the establishments, we find :—

[1] As the majority of pit-looms are plied by Mahomedans, their checking is undertaken with the help of a leading Mahomedan of the city, and this is not yet quite complete.

Locality	1 Loom	2 Looms	3 to 5 Looms	6 to 10 Looms	11 to 25 Looms	26 and more Looms	Total
Rustampura	..	..	1	2	5	2	10
Sagrampura	3	8	14	10	15	3	53
Manchharpura and Mahidharpura ..	1	7	10	5	..	8	31
Navapura and Indrapura	5	2	10	..	2	3	22
Sayyadpura	8	10	4	4	1	1	28
Begumpura	..	4	17	8	7	2	38
Gopipura	7	13	26	13	3	2	64
Salabatpura	123	105	85	33	20	4	370
Scattered Areas	2	2	10	8	5+6[1]	..	27+6

There are—apart from the big spinning and weaving mills—43 establishments employing 20 and more persons and 42 employing 10 and more (but less than 20). It is important to note that the small establishments from 1 to 5 looms make up nearly 80 (78.2) per cent. of the total, the most typical being the 3 to 5 looms Karkhana. This fact raises questions about the status of the weaver (independent craftsman or outworker), the number and influence of the two well-known communities of weavers—the Khatris and the Momnas,—the organisation of the small Karkhana, the relation of the outworkers to the Mahajans and their place in the whole organisation of the weaving industry of the city. These will be studied in the next part of this paper.[2]

[1] Unvisited as explained in a note on a previous page.

[2] The writer is indebted to the University of Bombay for a grant to enable him to carry out the investigations.

CROP REPORTING IN AMERICA

By

S. THOTAPALI, M.A., B.ED.

1. INTRODUCTION

THE crop-reporting service of the United States of America is an impartial agency, operated in the United States Department of Agriculture in co-operation with 35 of the States and 300,000 voluntary crop reporters, for the collection, collation and publication of statistical data relating to acreage condition and production of crops, number and production of livestock, prices of farm products, and related information. Its primary purpose is to provide adequate, accurate and timely information concerning crops and livestock for crop and livestock producers. This information is also of value to handlers and consumers of farm products, and to those who provide products and services needed by farmers. The information supplied by the crop reporters concerning crops and livestock in their tracts or on their own farms is collated and analysed by the Crop Reporting Board at Washington as a basis for the crop reports. The crop reports are published in mimeographed form for immediate distribution (and printed subsequently). As soon as they are released summaries are distributed by mail, telegraph, telephone and radio.

2. ORIGIN OF THE SYSTEM

In the past dealers and speculators in farm products of the United States of America were obtaining enormous profits through the circulation of misleading reports concerning crops, and through producers' lack of market values. Farmers were resentful of this and there was considerable agitation and discussion concerning the possibility of producers having adequate and accurate information regarding crop production before their crops had gone to the market. For public benefit therefore the Government of the United States in 1839 began to collect and publish agricultural statistics. The work gradually developed until 1912, when the Crop Reporting Board, organised in 1905, began to forecast production of important crops prior to harvest. With the organisation of the Bureau of Crop and Livestock Estimates in 1914, definite recognition was given to the value of the work of the Government of the U.S.A. regarding crop estimates particularly to farmers and stockmen.

3. ORGANIZATION

The principal base for crop statistics is the information collected by the Bureau of Crop and Livestock Estimates, Washington. The field force of the Bureau consists of an agricultural statistician in each State or group of States, and in larger States, additional assistant agricultural statisticians. These men must be of high character, qualified by training

and experience for their work, competent judges of crop production, and familiar with local conditions in their States. Each is required to travel over his State systematically during the crop season, personally to inspect the crop and to interview and obtain information from farmers, heads of commercial houses, mills, elevators, buying and selling associations of all kinds, transportation companies, State and Local authorities, and associations of every description. In fact, each is expected to be better informed on the general farming situation and on crop and livestock production than any other man in the State. Each agricultural statistician enlists the voluntary services of from 250 to 300 selected crop correspondents designated as 'aids,' who report to him every month regarding the crops grown in the State. At the close of each month he makes a detailed estimate of the crops in his State and forwards it to Washington with full explanatory notes. Many of the voluntary correspondents are selected after personal interviews to determine their qualifications. Branch offices are also established in various States to accumulate for record, study and comparison, all data available relating to the statistics of agricultural production in the respective States.

In addition to the salaried agricultural statisticians and crop specialists, the work has the co-operation of over 300,000 voluntary crop reporters, mostly farmers. These men are public spirited citizens who serve without compensation, enjoying the satisfaction derived from contributing information regarding local crop conditions of practical and financial value to themselves and to other producers, and receiving only such crop reports and bulletins as may be available for distribution to them. The farmers who are voluntary crop reporters contribute data regarding acreage, condition, yield, etc., for their localities and the Bureau of Agricultural Economics tabulates and summarises such data in the form of Government Crop Reports by each State and the United States at large.

4. The Crop Reporting Board

The preparation and publication of the monthly crop reports of the United States is the duty of the Crop Reporting Board, which consists of a chairman, the technical staff of the Division of Crop and Livestock Estimates, and two or more agricultural statisticians from the field offices of the Division. The procedure adopted by the Board in preparing crop reports may be briefly described as follows.

The first step in the preparation of the forecast by the Crop Reporting Board is the study of the comments of the agricultural statisticians, State by State, in the light of what has happened during the previous month in each State, taking into account the weather changes, soil condition, progress of cultivation, relative quantity of fertilisers used, presence or absence of insect pests and plant diseases, effect of these and other factors, appearance and apparent conditions of crop, and prospective yield. The second step is the forming of an estimate by each member of the Board, separately and independently, by examination of the following data : (i) individual estimate of the agricultural statistician ; (ii) weighted averages of returns from correspondents ; (iii) weighted average of special reports, if any ; (iv) estimate of the Board for previous month ; (v) estimate of the Board for the corresponding date of previous year ; and (vi) the ten year average estimate of the Board for the same date.

The third step is the comparison of individual estimates of members, which are usually in close agreement. Where much difference exists, the available evidence is carefully reviewed and discussed until agreement is reached.

When the basic figures for a given crop in a State have been determined by the Board, necessary computations are made to ascertain the probable total production for each State and for the United States. The figures are then entered in Tables which show State and United States comparative data, usually for the previous month or year and 5-year or 10-year averages. These Tables with comments constitute the forecast, which is released at the hour and minute previously announced.

5. Determination of Acreage

The main items on which crop estimates are made by the Crop Reporting Board are: (a) acreage indications for each crop as season advances; (b) acreage changes for each crop from season to season; and (c) the yield of each crop. These items may be briefly considered here.

(*a*) *Acreage indications :* The determination of the harvested acreage of crops is one of the most difficult problems for the Crop Reporting Board. The estimate of acreage that is likely to be harvested is made periodically as the season advances. The programme covers in a general way : (i) indicated acreage of important crops to be planted ; (ii) estimate of acreage of a few major crops at or about planting time ; (iii) early season estimate of crops to be harvested ; and (iv) estimate of acreage of crops harvested.

(i) Indicated acreage of crops to be planted : The intention to plant reports are based on schedules issued for the purpose, and are corrected in the light of the harvested acreage of the previous season. The indicated acreage may be said to be the acreage that will be planted if the growers make the usual adjustment to weather conditions and other factors affecting their final action, and if they fail, to the extent they usually do, to plant as large an acreage as they planned or hoped. The reports are made available to the public before planting actually takes place.

(ii) Estimate of acreage at planting time : For nearly all crops for which estimates of production are made, forecasts of acreage are made during the growing season. The Crop Reporting Board estimates on July 1, the acreage of each crop based upon June acreage schedules. These reports are, however, not intended to represent the total acreage planted since early planted acreage may be abandoned about July 1. Such incidental loss of acreage is allowed for in the process of estimating by the Board, in order that forecasts of production may be more nearly comparable with subsequent estimates.

(iii) & (iv) Estimates of crops harvested and to be harvested : In December of each year, acreage actually harvested is separately and independently estimated, taking into account the various changes in utilisation of many crops. Small grains are cut for hay (or sometimes pastured), hay crops are often pastured, certain crops like legumes are harvested partly for grain and partly for hay, some acreage is ploughed under for green manure or for other reasons. Revised estimates of

acreage planted are not ordinarily made except for cotton and fall-sown grains. Extensive and detailed data are collected for the December estimates, since these are the measures of production that stand on the record to represent trend of agricultural production.

(*b*) *Acreage changes from year to year :* The basis, or foundation, of all accurate reports of crop production is not only the acreage in the particular crops reported, but also the total acreage in cultivation and an accurate determination of changes made from season to season. Several good methods, which altogether give reasonably accurate measure of annual changes in acreage, have been used by the Crop Reporting Board. The more important of these are : (i) individual farm survey method ; (ii) ratio-relative method ; (iii) crop-meter ; and (iv) other methods.

(i) Individual farm survey method : This is still a very important method and consists in getting from a large number of individual farmers the acreage figures for their own farms for each crop in the previous year. The individual farm surveys are made twice a year—first in June by mailing out schedules to about 300,000 farms to furnish data for July 1 acreage reports ; and second in September, over a half-million schedules being sent out through rural carriers—and afford the basis for December revisions. The material, when received, is grouped into four classes to avoid giving undue weight to large farms, which usually constitute a preponderance of the returns. With this data the acreage is determined, and a direct comparison of the acreage in each crop reported on the same farms for the two years is made, from which the percentage of change in each crop is determined, weighted by district or country.

(ii) Ratio-relative method : This is a method of arriving at the change in acreage for a given crop from one year to another from a comparison of the ratio which each crop bears to all crops (or to all land in farms) on sample farms. For example, if it is found that on a sample farm corn constitutes 30% of the area devoted to crops for 1938 and 33% for 1939, there is an indication of a 10% increase in the acreage in 1939 over 1938. There are two important presumptions in this method: (1) an identical total acreage for each of the two years—a very doubtful assumption ; and (2) a sufficiently large sample—an insufficient sample reflecting fluctuations in sample rather than fluctuation in actual acreage !

(iii) Crop meter : With a view to avoiding the inevitable bias in the above subjective methods, a system of measurement of the frontage of crop fields along a highway, by means of a "crop meter" attached to an automobile speedometer, has been introduced. It is stated to be of inestimable value in indicating the relative change in acreage from one year to the next for cotton and some other crops. The frontage of each crop along representative routes is measured each year, enabling a direct comparison of the acreage between the current year and the previous year.

(iv) Other methods : In some States the correspondents are asked to report the number of acres of a given crop in 100 acres of various crops in the farm. By comparing the percentage from year to year in various kinds of crops it is possible to work out fairly accurately changes in the area of crops. In a number of States assessors are required to record the acreage

of crops. These are said to be very useful. Some work has also been done in correlating prices and other factors with the acreage in the succeeding year. Studies of this kind are being made for various crops, and it is believed that they will afford a very valuable check on other methods. Use is also made of records of receipts at mills and elevators, and shipments of grain, and the ginnings of cotton, which afford ways of checking the acreage figures of crops, and keeping the Department from getting very much out of the line.

6. Forecasts of Crop Production*

The problem of forecasting the probable production of a given crop during the growing season may be divided into two phases—estimating the acreage of the crop to be harvested, as described in the previous section, and forecasting the problable yield which will briefly be described here. The forecasting of yield is based upon the relation of the condition reports, or estimates of the condition of the crop, expressed as a percentage of normal in the current year, interpreted on the basis of the relation of condition and final yield in past years. The crop reporters are asked to report on the condition of the growing crop in percentage of a normal or full crop.

Before describing how the forecast of yield per acre is made with the information supplied by crop reporters, the term "normal condition" may be briefly explained. Now, "normal condition" is synonymous withfull "condition," giving promise of a full yield per acre. "Condition" refers to the status of the crop in comparison with normal growth and vitality at a particular date. The individual crop reporter compares the present appearance (state of growth, healthfulness, freedom from disease, tilth of soil, etc.) of the crop with his mind picture or concept of how the crop should look at this time to yield a normal or full crop. He reports the former as a percentage of the latter.

The making of a forecast of yield per acre on the basis of the data available on the first of a given month during the growing season is a statistical problem in the relationship between a series of data currently available and the yield per acre series over a period of years. These series are graphically correlated with yield per acre over a period of years as a dependent variable, and the appearance of the crop at a given date, such as August 1, measured by the crop reporter's estimate of "condition of the crop as a percent of normal" as an independent variable. As a matter of actual procedure, however, the regression lines are seldom computed. In the place of these lines it is customary to draw in lightly a proportional line through an observation for a year in which the yield can be carefully checked. Such a year is, for example, 1929 in which a complete census enumeration was made of the acreage and production so that actual yield per acre could be computed. It is not necessary that this proportional line should pass very closely to the mean of the observations since its principal value is to orient the observer with respect to the location of the point of zero condition and zero yield when it is not convenient to show that point on the chart.

* The information for this section was kindly supplied by the Chairman, Crop Reporting Board, U.S.A.

To illustrate. The chart shown below was used to determine the indicated yield per acre of alfalfa hay in the State of Ohio in September 1937. The line, P 29, is drawn through the observation for 1929 and the zero-zero point of the chart. The points circled are the yields established

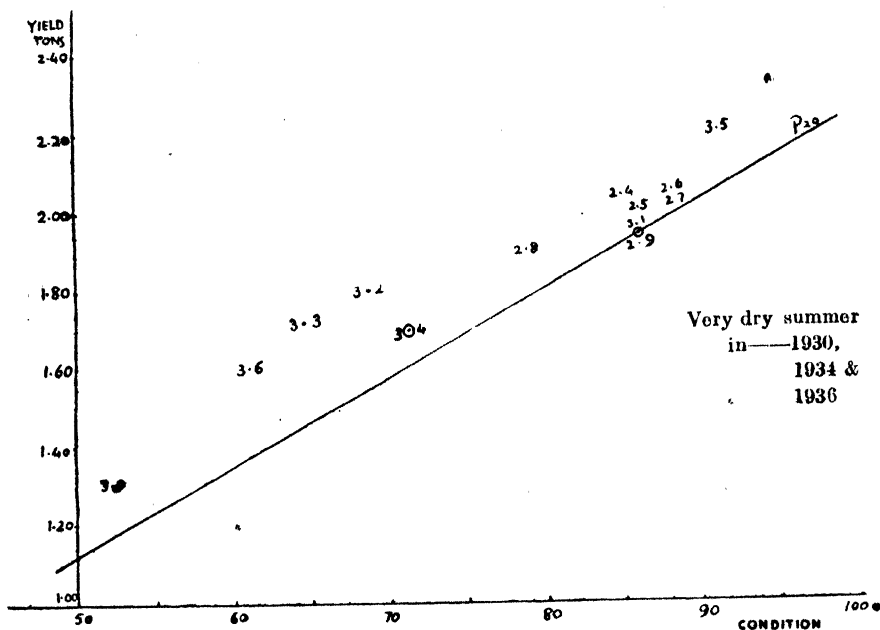


Chart used to determine the indicated yield per acre of alfalfa in the State of Ohio from the reported condition on September 1, 1937

by the census enumerations of 1929 and 1934 related to the respective reported condition. In September 1937 the reported condition of alfalfa hay in Ohio was 81. The intersection of the 81 condition line and the line representing the most likely relation between condition and yield in that range of the chart was close to 1.90 tons which was accepted as a reasonable forecast. This indicated yield is, however, not final but may change somewhat when further information is available. The condition figures shown on the chart are those reported by reporters, including bias, if any, related to the finally determined yield per acre which is based upon all the information available from whatever source. It is stated that this arrangement effectively takes care of any unusual or constant bias in the independent (or reported) variable.

Estimates of crops yield per acre are also made at or after harvest, based on analysis of reported community or individual farm yields in relation to census or other known yields. The reported yields per acre by crop reporters being more or less selective, usually need adjustment to conform to the average for all farms and all communities. Consideration is also given to memory and cash crop bias in converting reported yields to actual yields. When official estimates of yield per acre are compared with yield per acre derived by dividing production reported by the census, it is stated that the two are in reasonably close agreement.

The problem of forecasting yield per acre is also being approached from an entirely different angle. Each method so far outlined requires the individual crop reporter to interpret the effect of weather conditions upon yield. Attempts are being made to measure mathematically the relationship between early growing season weather condition and final yields. The methods are complicated owing to the large number of weather factors which affect yields, but in general they are an extension of the correlation method. The United States Weather Bureau has been studying the relation of weather factors to yields. The results so far obtained are said to be sufficiently promising to justify much more extensive investigation than has been attempted heretofore.

7. Use and Value of Crop Reports

It is claimed that the crop reports and statistics published by the Government benefit all classes of people in the United States, especially producers, marketing and distributing agencies, because they relate to the essential facts of production and supply of food and raw materials, and are unbiased, disinterested, authoritative and timely. The value of the reports is outlined as under* :—

(*a*) Farmers :

Directly—

1. Guide to increasing or decreasing acreage of particular crops.

2. Guide to marketing—whether to hold or sell.

Indirectly—

1. Prevents issue of biased, false and misleading reports or minimises their effect.

2. Reduces speculation.

3. Aids transportation companies to furnish proper supply of cars.

4. Better distribution of farm equipment and supplies.

(*b*) Co-operative Farmers' Associations :

Enables them to formulate constructive programmes and policies, and market their products intelligently.

(*c*) Dealers and Handlers of Agricultural Products ; and

(*d*) Agricultural Extension Workers :

Aids them in preparing crop production programmes.

(*e*) States Marketing Bureaux :

Aids in developing State marketing programmes.

(*f*) Bankers and Financiers :

Enables them to provide in advance funds needed to finance crop production, storage and marketing.

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* W. F. Callander, "The Government Crop Reporting Service."

(g) Railroads :

Enables them to estimate number of cars that must be provided to move crops.

(h) Insurance Companies :

Furnishes data on which to base crop insurance and to place farm loans.

(i) Manufacturers and Merchants :

1. Guide to determining quantities to manufacture.
2. Make best geographical distribution of product.
3. Show where to concentrate selling campaigns.

(j) Advertising Agencies:

Where to place advertising to the best advantage.

(k) Produce Exchanges:

Permits better adjustment of prices from day to day.

(l) Prospective Investors and Settlers :

Guide to relative agricultural resources and advantages of different parts of country.

(m) Economists :

In studies of business and agricultural conditions.

(n) Businessmen Generally :

Guide to determining whether to expand or contract.

8. EFFICIENCY OF THE UNITED STATES SYSTEM

The International Institute of Agriculture at Rome considers that the Crop Reporting Service of the United States is more thorough and complete in its work than that of any other country. The volume of information compiled annually regarding agriculture, the accessability of the information, the application being made of it to the great problems of the country, is really admirable. Its low cost is due to the fact that the reports are supplied by the leading citizens of each community gratuitously. It is the clearing house for the statistical information contributed by those interested in agriculture, and it is intended to benefit all who study and utilise the material available.

A SUGGESTION FOR WAGES OF RING SPINNING IN COTTON TEXTILES

By

VRANDAVANDAS B. KOTADAWALA, B.SC., and HASMUKH P. OZA, M.SC.,

Dharmendrasinhji College, Rajkot

IT is a pity that industry which reaps the greatest benefit from technical advance is very tardy in adopting scientific methods in its working. Payments of wages, to take an instance, are purely on supply and demand basis. This, it may be argued by some, is the most natural and therefore the most scientific method. But the days of the *Laissez-faire* policy are numbered, wherever not already gone, and it is an admitted duty of every Government to safeguard the interests of its members and stop any organised exploitation of one section by the other. But independent of any Government interference any far-sighted industrialist can at once see that a satisfied worker is ultimately more paying ; nay, still further, the wage-system should be such, consistent with the profit to industry, that the workers may be impelled to put in more labour. In absence of this far-sightedness industry drags on like a bullock cart on a stony uneven path with jerks, halts and a lot of noise besides. Ordinarily when there is a wage dispute, strikes are resorted to, except in a few centres like Ahmedabad where the principle of arbitration is prevalent. But as Gulzarilal Nanda remarks, "Experience has demonstrated the futility and inconclusiveness of industrial warfare on the issue of wages, which has supplied a test of nothing more than the staying power of the parties, and the outcome of which can furnish no indication at all of the merits of the particular dispute."[1]

For what follows it is not claimed that either it will do away with disputes altogether or that associations (or Unions) will not be required to settle the disputes and to make alterations in the wages as time may demand. The aim is a much humbler one. It is to discuss the wage system in the ring spinning section of cotton textile industry with reference to the number of spindles in a machine so that,

(A) it may prevent a wage-war when labour realises that it is exploited (as will be shown below) ;

(B) it may not only keep labourers well satisfied but also may impel them to exert themselves more ;

(C) it may progressively leave more profit to industry.

Over and above (C), (A) and (B) as well will go a long way to the betterment of industry.

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1 Preface to Volume IV of "History of Wage Adjustments in Ahmedabad Industry," T. L. A. Publication.

For the building up of our theory we need consider the wage system as actually prevalent at some important centre. For obvious reasons we select Ahmedabad. The data of Ahmedabad, relevant to our purpose, is given in Tables I and II.

An examination of the data for Ahmedabad calls for the following remarks :—

(*a*) Taking the basic rate of Rs. 12-8-0 for warp for less than 340 spindles, that is for the interval 301-339, and so may be taken to be for 320, it seems that a mill does not pay at a rate less than 200/320×2=1.25 As. per spindle. For 40 spindles (as is spoken ; otherwise really only 20) then, it does not pay less than Rs. 1-9-0. It follows, therefore, that the basic rate for 340-380 should be, taking the wage for the mean to be the wage for the interval, Rs. 13-4-6, instead of Rs. 12-12-0; and a corresponding increase for 'greater than 380.' It may be argued that when a mill provides for a more up-to-date and consequently a better machine it expects to accrue more profit. More profit, indeed, it should accrue, we do not contend ; but it should leave a margin necessary for a healthy impetus to labour.

(*b*) Doublers (those who work two sides), according to basic rates, are paid 45% and 47½% more for fine and coarse counts respectively, showing that the mill management pays at least 45% more either as a necessary stimulus or ethically necessary or both.

(*c*) Deductions from the wages of a worker, consequent to his absence, are not uniform : Some mills calculate on the basis of 14 working days and others, including two holidays, on the basis of 16. The latter is beneficial to the absentee (permanent worker), and the former clearly more just to the reliever.

(*d*) The basic rate has passed through many vicissitudes doing damage to an already defective system : Increment due to the T.L.E. Committee of 1937 has done away with even the small difference of Annas 4 that existed in the rates for 340-380 and for 'more than 380'— both to be paid Rs. 15-1-3 ; and doublers do not get 45% and 47½% more than the single siders. Also a proper difference in the wages of warp-work and the correspondingly more difficult weft-work is not maintained as will be seen from (*e*) and (*f*) below.

The above two points clearly indicate the need of starting with a clean slate.

(*e*) The Delhi award of 1935 shows that both the parties agreed to give greater increments to coarse count than to fine count. But the wise and the learned members of the T.L.E. Committee proposed such a system of increments that *a coarse count warp doubler of* 340-380 *gets Rs.* 20-11-6 *whereas a corresponding fine count doubler gets Rs.* 20-15-3 *! The more difficult a work, the less the wages !*

(*f*) And this is not all. *A coarse count warp doubler of less than* 340 *gets Rs.* 20-15-3, *whereas that of* 340-380 *gets Rs.* 20-11-6 *! The greater the work, the less the remuneration!* These absurdities wrought by the T.L.E. Committee proposals are too glaring to be emphasized.

(*g*) The maximum number[2] of spindles in Ahmedabad is 504 in the jubilee mills. Next comes the Kaisar-e-Hind where there are some machines of 496 for weft. The latter, however, at least deems it necessary to pay more than the wages for 'greater than 380.' It pays Rs.1-5-3 in addition per *hapta* for weft. Injustice (more in the case of Jubilee) is too obvious to necessitate emphasis.

From the above considerations one may jump at a conclusion that *at least* 45% of what otherwise the mill would have to spend on spindles, a labourer who works in addition to 338 (less than 340), had only the machines been of less than 340, at the rate of Rs. 12-8-0 for 320 spindles, should be paid as an additional remuneration to him. One consideration, however, is left out: working of one spindle more in addition to *any* number already worked does not add the same amount of strain on the part of a labourer. In fact *the strain for an additional spindle increases as the number of spindles to be worked increases.* That is if a labourer is already working n[3] spindles then the strain for working $(n+1)$th spindle also increases as n increases.

The graph will clear the point.

OPQ is the curve giving the wages for a given number of spindles above 320. $\frac{dy}{dx}$ of this curve increases with x. That is whenever OC>OA and AB=CD we must have C'D'>A'B'.

Our problem then reduces to finding a formulae for wages, for warp (weft will follow by adding a constant amount to the wages for warp), such that :—

(*i*) It gives the additional remuneration to be paid to those who are working more than 320 spindles ($2n=320$).

(*ii*) Remuneration increases with the increment in the spindles to be worked and in fact, for $(n+1)$th spindle, it increases with n— after $n=160$.

(*iii*) The basic rate for less than or equal to 320 spindles is Rs.12-8-0. It may be noted that this may be altered; this paper mainly stands for the method of attacking the problem.

(*iv*) It may be so fixed, consistent with (*ii*) and (*iii*), that a labourer can get 50% more when he is working a 640 spindle machine than when he is working a 320 spindle machine. As we have already seen, the doublers get 45% and 47½% more for fine and coarse counts respectively. And also it is agreed that corresponding to the number of double-sides worked 10% more doffers should be engaged. These two combined give slightly more than 50%; but then we have a slightly increased waste of cotton to induce us to keep 50% increment at 640. For coarse count, the workers

[2] Calico has recently brought five machines of 584 spindles and at the time of writing two were already installed.

[3] Here we are talking of the actual number of spindles worked and not taking n, as is usual, to denote the total number of spindles in a machine. It is customary to speak of the total number of spindles in a machine ($2n$) to be the number worked, although the actual number of spindles worked by a single tenter is half of it, namely n.

should certainly be paid slightly more—say for 640 he may get 52½% more rather than 50%. We have, however, given the calculations and tables for the fine count; for the coarse count a corresponding change will give the result.

It may be argued by some that when we ask the mill industry to spend the same amount, say, for a 640 spindle machine as for a double-working 320 spindle machine and so on, what inducement do we leave to industry to instal bigger machines? The answer is simple: Even when bigger machines are provided the principle of rationalisation can be applied.

(*v*) In order to apportion the rates of increments, it will be seen that we need fix an increment for some specific interval. For practical purposes, we propose fixing the constants of the formulae to be adopted such that, consistent with (*iv*), they will give the remuneration of Annas 4 for first 20. It again may be noted that, after all, this is mainly arbitrary and hence may be conveniently altered; any such alterations, however, leave the chain of arguments unaffected.

An obvious and a convenient formulae that suggests itself is

$$Y = aX^2 + bX$$

where X represents the *actual* number of spindles to be worked in addition to 160,[4] and Y represents the remuneration in annas, to be paid *for* X.

Using (iv) and (v) we determine 'a' and 'b' and get the formulae in its final form as

$$Y = \frac{3X^2}{2000} + \frac{77X}{200}$$

The graph of this is attached herewith from which Y for any number of spindles can be read. The Table III gives the necessary results. In order to arrive at the final wages a suitable constant—due to attendance bonus and monghwari—should be added to the basic wages given in Table III. In the system advocated above, doublers, as before, may be paid 45% and 47½% more for fine and coarse counts respectively. And a *lambhan* doubler may be treated as a single-sider of a machine of double the number of spindles.[5] Suitable alterations in the clauses (*iv*) and (*v*) and even in (*iii*) may be made to meet the demands of time. The aim of this paper, as stated already, is to propound a method of arriving at a more just wage-system. Such a system will serve as a stimulus to a worker to put in more work with the result that *fewer workers will be required, and consequently dearness allowances, etc., will have to be paid to fewer persons.*

[4] Here and in what follows, unless explicitly stated otherwise, we will be speaking of actual number of spindles worked (*n*).

[5] So far in Ahmedabad nowhere except in Kasturbhai group the *lambhan* double is being worked; and the workers are paid a rupee more than the corresponding doublers—again a glaring injustice.

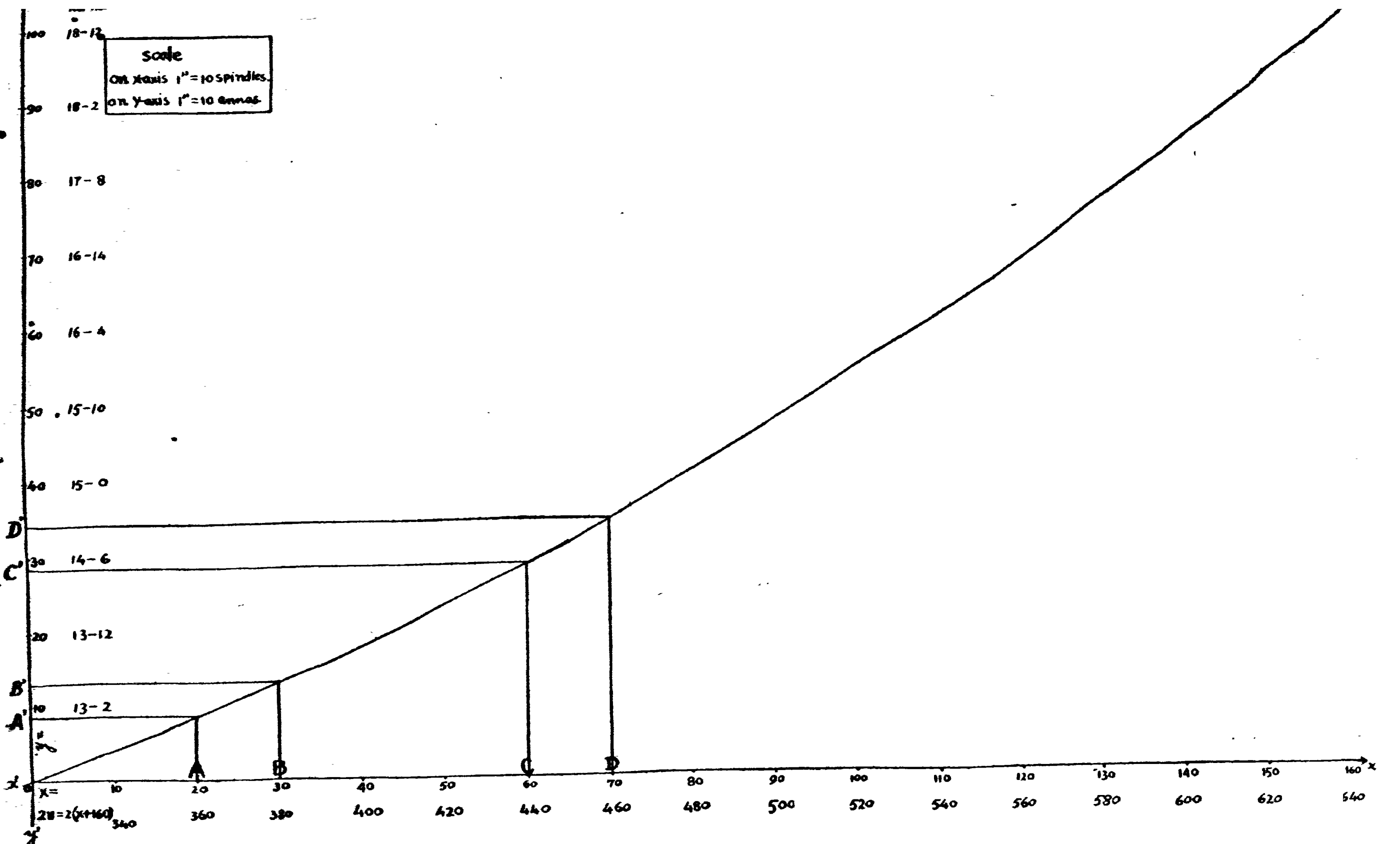

Scale
on X-axis 1" = 10 spindles.
on Y-axis 1" = 10 annas
18-12
18-2
17-8
16-14
16-4
15-10
15-0
14-6
13-12
13-2
A'
B'
C'
D'
A
B
C
D
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
340 360 380 400 420 440 460 480 500 520 540 560 580 600 620 640

TABLE I

Ahmedabad Centre

WAGES TO RING SPINNING PIECERS IN 1921 PER PERIOD OF 16 DAYS (INCLUSIVE OF 2 HOLIDAYS).

For Spindles =2n	Warp Singles[6]				Weft Singles[6]			
	Basic	+Dearness allowance	+Bonus	Total	Basic	+Dearness allowance	+Bonus	Total
∠ 340	12 8 0	1 10 0	1 0 0	15 2 0	13 0 0	1 10 0	1 0 0	15 10 0
340-380	12 12 0	1 10 0	1 0 0	15 6 0	13 4 0	1 10 0	1 0 0	15 14 0
7 380	13 0 0	1 10 0	1 0 0	15 10 0	13 8 0	1 10 0	1 0 0	16 2 0

TABLE II

Ahmedabad Centre

From time to time changes in the wages of 1921 were made. In 1923 Anandshanker Dhruva Award effected a cut of 15.6% ; in 1930 8% increment was agreed upon ; and in 1935, again, Delhi award gave a cut of 6.25%. Also by Delhi Award provision for double side piecers was made and they got 45% and 47½% increments for fine and coarse counts respectively. Then in 1937 the T.L.E. Committee appointed by the then existing Congress Government gave increments which are given in the fourth column below.

WAGES TO RING SPINNING PIECERS FROM 1938 PER PERIOD OF 16 DAYS

Type of work	No. of spindles	Warp Section			Weft Section		
		Total wages in 1936	Rate of increase per Re. by T. L. E. Committee	Present wages	Total wages in 1936	Rate of increase per Re. by T. L. E. Committee	Present wages
I Singles	∠ 340	12 14 6	0 2 6	14 14 6	13 5 3	0 2 6	15 1 3[7]
	340-380	13 2 0	0 2 6	15 1 3	13 8 6	0 2 0	15 3 6
	7 380	13 5 3	0 2 6	15 1 3	13 12 0	0 2 0	15 7 6
II Doublers in fine counts (45% more)	∠ 340	18 5 0	0 2 0	20 9 9	18 14 0	0 1 6	20 10 3
	340-380	18 10 0	0 2 0	20 15 3	19 3 9	0 1 6	21 0 9
	7 380	18 14 0	0 1 6	20 10 3	19 8 9	0 1 6	21 6 3
III Doublers in coarse counts (47½% more)	∠ 340	18 10 6	0 2 0	20 15 3	19 4 0	0 1 6	21 0 9
	340-380	18 15 0	0 1 6	20 11 6	19 9 0	0 1 6	21 6 6
	7 380	19 4 0	0 1 6	21 0 9	19 14 0	0 1 6	21 11 6

Note :—In addition to the above wages a war allowance at the rate of Re. 0-7-4.6 per month per a rise of unit index number above the normal cost of living index number (73) is being paid since February 1940.

[6] In 1921 only singles were worked. And the process of rationalisation was very recently adopted in this centre from 1935 only.

[7] This was the maximum limit fixed for Re. 0-2-6 increment.

TABLE III

Proposed Basic Wages Per Period of 16 Days

FOR WARP

X=n-160	Y=wages in Annas to be given in addition to Rs. 12-8-0	2n=number of spindles on both the sides of the machines	Wages=12-8-0+Y annas	Taking the interval of 40(in 2n) as is now prevalent at Ahmedabad and adopting the wages of the mean to be the wage for the interval we have		Taking the interval of 20 (in 2n) and adopting the wages of the mean to be the wage of the interval we have	
				Between	Wages	Between	Wages
			Rs. As.		Rs. As.		Rs. As.
—30	—10.2	260	11 13.8			250–269	11 13.8
—20	—7.1	280	12 0.9	260–299	12 0.9	270–289	12 0.9
—10	—3.7	300	12 4.3			290–309	12 4.3
—0	—0	320	12 8.0	300–339	12 8.0	310–329	12 8.0
—10	—4	340	12 12.0			330–349	12 12.0
—20	—8.3	360	13 0.3	340–379	13 0.3	350–369	13 0.3
—30	—12.9	380	13 4.9			370–389	13 4.9
—40	—17.8	400	13 9.8	380–419	13 9.8	390–409	13 9.8
—50	—23.0	420	13 15.0			410–429	13–15.0
—60	—28.5	440	14 4.5	420–459	14 4.5	430–449	14 4.5
—70	—34.3	460	14 10.3			450–469	14 10.3
—80	—40.4	480	15 0.4	460–499	15 0.4	470–489	15 0.4
—90	—46.8	500	15 6.8			490–509	15 6·8
—100	—53.5	520	15 13.5	500–539	15 13.5	510–529	15 13.5
—110	—60.5	540	16 4.5			530–549	16 4.5
—120	—67.8	560	16 11.8	540–579	16 11.8	550–569	16 11.8
—130	—75.4	580	17 3.4			570–589	17 3.4
—140	—83.3	600	17 11.3	580–619	17 11.3	590–609	17 11.3
—150	—91.5	620	18 3.5			610–629	18 3.5
—160	—100	640	18 12.0	620–659	18 12.0	630–649	18 12.0
—170	—108.8	660	19 4.8			650–669	19 4.8
—180	—117.9	680	19 13.9	660–699	19 13.9	670–689	19 13.9
—190	—127.3	700	20 7.3			690–709	20 7.3
—240	—178.8	800	23 10.8	780–819	23 10.8	790–809	23 10.8

Addendum

Starting with Rs. 13 as the basic rate at 320 (2n) singles for weft and the other conditions (iv) and (v)—50% more at 640 and Annas 4 more for first 20—keeping the same, the constants 'a' and 'b' of our formula come out to be

$$a = 1/600$$
$$b = 23/60$$

Thus the corresponding formula for weft, with the same notations is

$$Y = \frac{X^2}{600} + \frac{23}{60}X$$

with the help of which Table IV is prepared.

TABLE IV

Proposed Basic Wages Per Period of 16 Days

FOR WEFT

n-160	2n	Y	Interval	Total basic wages=13-0-0 † Y as.	Adding 45% more corresponding wages for doublers
				Rs. as. ps.	Rs. as. ps.
-20	280	-7	260–299	12 9 0	18 3 5
0	320	0	300–339	13 0 0	18 13 7
20	360	8⅓	340–379	13 8 4	19 9 8
40	400	18	380–419	14 2 0	20 7 8
60	440	29	420–459	14 13 0	21 7 8
80	480	41⅓	460–499	15 9 4	22 9 6
100	520	55	500–539	16 7 0	23 13 4
120	560	70	540–579	17 6 0	25 3 1
140	600	86⅓	580–619	18 6 4	26 10 9
160	640	104	620–659	19 8 0	28 4 5
180	680	123	660–699	20 11 0	29 15 11

Appendix

For our own curiosity we collected the full data of 22 out of the 66 mills of Ahmedabad in order to have a comparative study of the existing wage bills and the wage bills in accordance with the proposed theory. For calculations the interval of 40 in *2n* is taken ; also Re. 1-0-0 as attendance bonus is added to the basic wages to arrive at the final wages. Attendance bonus is an industrial necessity as it tends to reduce the number of absentees.[8] Dearness allowance of Re. 1-10-0 of Table I is not added as it is irrelevant after the adoption of the sliding scale.

The comparative study, in nutshell, is given in Table V, in which mills are given numbers instead of their current names, although we are fully aware that it will not be difficult to identify them.

8 At no distant date we propose publishing our study of absenteeism with reference to Ahmedabad.

It is found from Table V that the proposed system leaves to industry, on the average, 3.1% of the existing wage bills. With slight change in the amount of bonus it is possible to equalise the two wage bills. But the purpose of the paper being to arrive at the wage rates based on the principles of justice and industrial necessity, we have tried our best to do away with the patch work. It is merely a happy coincidence that the two wage bills differ so little.

It is a suggestion from the authors that the residue of 3.1% may partly be utilised for the purpose of sickness insurance[9] and partly as efficiency bonus for the quality and quantity of work put in by the worker.

If the authors find that the paper is given the careful perusal it deserves and that the economic principles advanced therein, as well as its method of attack, are likely to be adopted in practice, they may, in accordance with their wish and plan, proceed with the study of wage systems in cotton textiles with a special reference to Ahmedabad.

TABLE V

Comparison of the Existing Wage Bills with the Proposed Ones

Mill (A)	Existing wage bills (B)	Proposed wage bills (inclusive of attendance bonus of Re. 1) (C)	Difference between two wage bills B-C (D)	Percentage difference $\frac{B-C}{B}$ 100 (E)
	Rs. as. ps.	Rs. as. ps.	Rs. as. ps.	%
1	1,436 15 9	1 421 13 0	15 2 9	1
2	1,214 2 6	1,147 12 0	66 6 6	5½
3	1,497 2 0	1,409 6 9	87 11 3	6
4	459 3 0	449 14 0	9 5 0	2
5	1,791 6 6	1,656 7 6	134 15 0	8
6	1,549 6 0	1,463 3 0	86 3 0	6
7	849 4 6	971 0 0	—(121 11 6)	—(13)
8	816 3 9	811 12 3	4 7 6	½
9	1,008 5 0	995 0 3	13 4 9	1
10	1,927 3 6	1,787 3 3	140 0 3	7
11	995 3 9	1,005 10 3	—(10 6 6)	0
12	914 11 0	939 3 0	—(24 8 0)	—(2)
13	1,791 1 9	1,756 2 6	34 15 3	2
14	1,866 1 6	1,785 8 3	80 9 3	4
15	1,098 4 9	1,070 11 6	27 9 3	2
16	1,920 15 0	1,863 0 0	57 15 0	3
17	1,344 8 6	1,314 4 0	30 4 6	2
18	916 6 3	936 15 9	—(20 9 6)	—(2)
19	1,754 3 6	1,693 13 6	60 6 0	3
20	1,252 13 0	1,196 0 0	56 13 0	4
21	2,412 13 0	2,301 4 0	111 9 0	4½
22	1,806 10 6	1,700 1 3	106 9 3	6
Total ..	30,623 1 0	29,676 2 0	946 15 0	3.1

Average percentage difference is 3.1%.

Average deviation without regard to sign is 4.25%.

[9] A suggestion for the provision of sickness insurance is made in the "Report of the Textile Labour Enquiry Committee" published by the Bombay Government in 1940, Vol. II, page 409, Recommendation No. 315.

SOME TAMIL FOLK-SONGS[1]

By

M. N. ŚRĪNIVĀS, M.A., LL.B.,

Research Assistant, Department of Sociology, University of Bombay

THE importance of folksongs as the repository of the customs, beliefs, hopes and aspirations of the mass of the people needs hardly to be emphasised to-day. Their sociological, philological, and even literary importance is now a matter of tacit assumption. And especially in India today where the intelligentsia and the masses live in different, and almost closed worlds, one of the important ways in which the former can understand the latter is through the study of folksongs. The study of folksongs implies sympathy with the masses, for folksongs are human documents revealing along with the special customs, beliefs and institutions, fundamental human hopes, aspirations, sorrows and frustrations.

Tamil is a very old language, having reached a high stage of development even when it first came into contact with Sanskrit. It is also the most individual of the Dravidian family of languages, and as such, the importance of collecting Tamil folksongs cannot be overestimated.

But, unfortunately, very little of the vast harvest has been gathered, and, that too, only by *litterateurs*,[2] and not by sociologists and philologists. A good many songs with little literary value may be profoundly significant from the point of view of the sociologist and the philologist.

Again, renaissance in Tamil literature—assuming militant forms to-day—began much earlier than in Kannada, but there is a larger collection of folksongs in the latter than in the former. It is to be hoped that some well-equipped persons will soon wake up to the urgent task of collecting folksongs. The task should be undertaken here and now, for I think that they will soon be stamped out of existence by the touring talkies. Rural people are already looking forward to urban-created entertainment, and the road-roller of civilization is flattening out all individuality under its heavy iron wheels. Rural people are getting increasingly sophisticated—their songs, even love songs, no longer interest them, and they would rather whistle the tune of a popular film actress from the latest picture that has reached the town within walking-distance from their homes.

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[1] These songs were collected during my tour as Research Assistant in Sociology, in the villages round about Chidambaram. Messrs. T. M. Pichchandi, T. Ramakrishnan and K. M. Ramaswami, all assisted me in the task of collecting the data, and to them are due my sincere thanks. I am grateful to Mr. S. Rudrapati, M.A., Lecturer in Tamil, Mysore University, who assisted me in the task of translation. I must thank Dr. G. S. Ghurye for his guidance.

[2] Mr. R. Krishnamurthy, Editor, the 'Kalki,' and Swami Shuddananda Bharatiyar have published some Tamil folk-songs, but with no accompanying translation in English.

The cinema has penetrated into every nook and corner of the Tamil land. Still, some areas are relatively free from such influence, and it is thither that the interested collector should first go. West of Arantangi, where the railway line ends, is a fruitful area, and so are some parts of the Tinnevelly District. It is here that one is likely to find relatively 'pure' songs. Collection at more than one place is necessary as variants are significant, and help us to disentangle the cultural skein.

Folksongs, barring ballads which (say) narrate the life and death of a hero, do not have the continuity of a tale. They are very often fragmentary. They are a medley of snapshots and not a full-length film. Add to it the fact that frequently sound dictates the choice of words. The singer sings about whatever comes to his mind, and here only the law of association seems to guide him.

There is no written record of the folksongs, and they are perpetuated only by memory. And memory is not a certain guide, especially where no sense of religious sanctity is attached to the mode of singing, and to the words themselves. Each generation leaves its mark on the songs, so much so that the original lines may come to be twisted out of all recognition. English words have crept into the songs, and we even find the train mentioned in a *Kannigaḷ Pāṭṭu.*

Another factor that has to be borne in mind is that a full understanding of the folksongs requires a general knowledge of the culture and institutions of the people, and also the local peculiarities of the area in which the songs are gathered. Thus, lines which appear utterly meaningless to the outsider may be charged with significance for a member of the community in that locality.

Old Tamil folksongs are known by the name of *Karnāṭa* or *Karnāḍa* songs, and the reason for this fact is not clear. Why should *Karnāṭa* signify the sense of antiquity?

Oppāris (which form the bulk of the songs collected here) are dirges sung by women, and they are certainly ancient. I learn that they are found even in the Tamil literature of the sixth and seventh centuries A.D.

The *Temmāng* is a ditty peculiar to the rustics of India. The *ḍappa* is a newcomer, attuned to the Hindustani style of music, and the *Tillāna*, also a youngster comparatively, is a kind of musical composition ending with the expression *tillāna, tillāna*. Barring the *Kannigaḷ Pāṭṭugaḷ* and the *Oppāris*, the others are sung whenever the villagers are in the mood for it—such a mood often occurs after a hard day's work, when the moon is shining on the crooked lanes of the village, and a bottle of arrack has let loose the spirit of *bonhomie.*

The following songs were all collected in the villages round about Chidambaram, on the Coromandel Coast. They were mostly collected from the Paryyans (Adi-drāvida, harijans), and Paḍyyācis (synonymous with the Paḷḷi agriculturist caste, very much higher in the social scale). But I learn that most of the songs collected herein are common to the entire Non-Brāhmin population.

Christianity, Islam and Hinduism all come together on the Coromandel Coast, and hence we find the folksongs reflecting the fact of the cultural confluence. There is a song in praise of the Virgin and the Cross,

and another in praise of the Muslim Deity of Negapatam. And it is but natural that the famous Naṭarāja of Chidambaram should be mentioned quite frequently. Subrahmaṇya, the boy deity of the Palni Hills, is mentioned time and again. He is easily the 'favourite' god of the Śaivite South, and he dominates the Tamil religious consciousness. The *Seven Kannis* (village deities) are also prominent, but I was surprised to find no song dealing with that very important village deity of Tamil land, Ayyanār. Incidentally, it may be said here that the exact area of the worship of Śiva as Naṭarāja (as the enemy of Andhakāsura), of Subrahmaṇya, of Ayyanār, and of the *Seven Kannis*, is not known. We want a study dealing with the various forms taken by these deities at various places, their penetration into other cultures, and the modifications undergone by them in the recipient cultures. Our knowledge of the Draviḍian, in terms of his social institutions and cultural affinities, is very scanty, and only a thorough survey of the field, that too done immediately, can lessen the depth of the prevailing black-out.

The first song is sung during a drought which is believed to be caused by Koḍumbāvi, the wife of Śukra. So the village women gather together, burn an effigy of her, and sing *oppāris* in the hope that her death will cause Indra to cool the earth with rain.

The next branch of songs, *viz.*, the religious ones, help us to understand the religious horizon of the Tamilian.

Koḍumbāvi Pāṭṭu or the Drought Song

The purpose of the following song is to cause rain. An effigy of a woman is made with straw, and it is called the *Koḍumbāvi* (lit. the very cruel sinner). *Koḍumbāvi* is said to be the wife of Śukra, the preceptor of the Asuras. Abuse is heaped on her for causing the drought.

On three successive evenings, the villagers, men and women both, go round the effigy which is laid on the ground, beating their breasts and singing the *oppāri* or dirge. The effigy is placed with its head towards the south (South is the abode of Yama, the God of Death, and people usually do not sleep with their heads towards it) and its hair-knot will be adorned with flowers.

After every song the Paryyan drummer beats the tom-tom, and sometimes he beats it at the end of every line. (This is indicated in the particular songs.)

On the third evening, one villager takes up an earthern pot in his hand (called *Koḷḷi Koḍam* or fuel pot, probably after the pot of fire held by the chief mourner in a funeral ceremony), and carries it before the effigy which is placed in a cart and dragged along the village streets. He puts rice into the corpse's mouth. The cart stops before every house, and the mourners sing the dirge and depart only after they have been paid some money. The effigy is taken to the end of the village and formally burnt. The songs that are sung when the effigy is being cremated are indicated at the end.

The purpose of the ritual is to dramatise the death of *Koḍumbāvi*, wife of Śukra, who is the cause of the drought. Her death should naturally result in rainfall.

Tamil	*English*
1. Nocci Ka*l*iveṭṭi[1] yē, keṭṭankoḍumbāvi, kēdugeṭṭa Canḍāḷi, Śukran penḍāṭi! śorane-geṭṭa veḷḷāṭi, poccīle kuccigeṭṭi inda noccīle pe*l*ada maḷy, un poccīle pē*l*aliyē!	1. (We have) cut the *nocci* stalk (from the tree), O, bad Koḍumbāvi! evil *Canḍāli* wife of Śukra, honourless servant-maid (we shall) tie the *nocci* to (your) vagina, (the) rain which rained in the *nocci* did not rain in your vagina.

As soon as the above song is over, the Paryyan beats the drum, and the people dance round the effigy till the next song is taken up.

Tamil	*English*
2. Ātte Kurukaḍytta, yē enna Keṭṭam Koḍumbāvi!	2. (We have) banked up the (drying) river,[2] O my evil Koḍumbāvi!
Kēḍugeṭṭa Canḍaḷi, Śukran penḍāṭi,	evil *canḍāli*, wife of Śukra,
śoranegeṭṭa Veḷḷāṭi,	honourless servant-maid,
nān oru a*l*agu śamba nāttu viṭṭēn,	I transplanted a beautiful *śamba*[3] (paddy),
inda āttu taṇṇīr vaṭra vaṭra, en a*l*agu śamba vāḍudaḍī!	(But) as the river's water dries up, my beautful *śamba* withers away!
3. Kuḷatte Kurakaḍyttu (drum beaten, *jinjān, jinjān*)	3. (We have) banked up the (drying) pond, (*jinjān, jinjān*),[4]
nān kuḷḷamśambā nāttu viṭṭēn (*jinjān*),	(I have transplanted the *kuḷḷamśamba*),[5] (*jinjān jinjān*),
Kuḷattu taṇṇīr vaṭra vaṭra (*jinjān . . .*),	But as the pond-water dries up,
en kuḷḷamśambā vāḍudaḍī!	my *kuḷḷamśamba*[5] withers away!
4. Oppāri vāśalile nān koppy ka*l*aṭi vyttēn,	4. Before the bewailing door I kept my koppu,[6]
oppāri śollimpōdu koppu pōna māyamenna?	how did the *koppu* disappear when (I was) singing the dirge?
5. Āttuku andāuḍe, oru annan vytta tennamaram,	5. On the other bank of the river, elder brother's coco-palm stands,
āru nilykkakkaleyō, aṇṇan, pōna māyamenna?	the river has too much water, How did *aṇṇan* disappear?[7]
6. Āṭṭrān kareyōram nānoru annam pōle kundirandēn,	6. On the river-bank sat like a swan,
enne annamenra pārāmal oru ambu pōṭu śuṭṭāne!	he burnt me with an arrow without having any compunction for the swan.[8]

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[1] *l* has been used for the sound 'zh' as in 'kuzhavan.'

[2] When the water in the river is too low, a small mud wall is put up to raise the water level, and then pumped into the fields by means of the *ēta* (described later).

[3] A variety of rice.

[4] The drums are beaten at the end of every line also.

[5] Variety of *śamba*.

[6] Koppu is an ornament worn at the top of the ear. While singing the dirge, it is probably thought right to remove the ornaments on one's person.

[7] The river is in spate suddenly, and the elder brother is carried away by it. The next song is almost indentical with this one, but for the fact that the *Koyandan* (husband's brother) is carried away by floods. So I have not reproduced it here.

[8] In the next stanza the woman compares herself to a cuckoo which is shot, and I have omitted it here.

Tamil	*English*
7. Śengamuḷḷu, nadi, kāḍu-janam perutta rājyangaḷ,	7. The *śenga*[1] thorn, river, jungle-countries full of men,
janamperutta rājyatte, saraswati māle iṭṭēn,	in such a country, (I) Saraswati garlanded,[2]
saraswatiyāḷ kaṇṇīr samudrangaḷ pōi pāyam,	Saraswati's tears will flow into the sea,
samudrattu pakṣiyellā jalamkuḍikka māṭṭēnenru,	(and) the sea-birds will refuse to drink the sea-water,
sadigāri, kaṇṇīr viṭṭēn !	(I who am a) murderess! (I) shed tears.

8. The woman's husband is dead and the relatives have come to remove the *tāli* from her person. She bewails her lot and just at that moment the *tāli* appears to her the most beautiful and beloved object in the world.

Tamil	*English*
Tanga perinśaraḍu, tāyambunaśśaraḍu,	The big gold-chain[3] (beautiful as a) screw-pine flower,
tālimēl kayye vyttāl,	(if they) keep a hand on my *tāli* (to take it away),
tāḷumē en manam ?	how can my mind bear it ?[4]

9. In the following poem, the woman is drying her hair after a bath, and she thinks that if she went to her mother's house with her 'lightning-like baby-son' at her waist, none would guess that she had just lost her husband !

Tamil	*English*
īra myrāti, iḷambiḷḷe tōḷ māti,	10. After drying the wet hair, after shifting the baby to the other waist,
nān piranda ilengeke pōne enrāl,	if I go to birthplace,
īra myrum, iḷambiḷḷe tōḷ a*l*agā,	the wet hair (and) the beautiful baby at the waist,
ilangiyale minnadee enbār.	—they would say that there is a lightning.
10. Terke pura kaṇarā (*jinjān..*)	10. (There is) a well to the southern boundary (of our village),
Anda dēśamellām pūnjaḍiyān,	(and that) country is all flower plants,
nāngaḷ tēngi erakkam taṇṇīr	We bank up water (and) pump it to the fields),
inda koḍumbāvi dēśamvandu kiṭṭṭaleyō !	this *koḍumbāvi* has ruined our place !
11. Vaḍakke purakaṇarā, ē en ācca vyramē !	11. (There is) a well to the north,[5] O, my beautiful diamond core (of wood),
arubadaḍi kambamē, tēkku palagamē,	My sixty-foot tall pillar, my teak plank,
ange vāśalellā pūnjaḍiyā, vāri erikkum taṇṇīr,	Flower plants are before their doors, (and) Water overflows,
inda koḍumbāvi dēśattile, ivaḷ vāśal vandu kittaleyo ! (*mēḷam*)	in the *koḍumbāvi* village, she has come to our doors (drum).

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[1] A variety of thorn.

[2] Means, 'married.' Saraswati gets married, but soon her husband dies.

[3] The *tāli*, or marriage-badge, is tied to the neck either with a yellow thread (either side of the *tāli* are coral beads and gold ones), or a gold chain.

[4] The next stanza is just a repetition of this one with very insignificant changes.

[5] The widow is mourning her husband, and praising his great strength. She compares him to the hard core of a mature tree, which is said to be strong and hard as a diamond.

Tamil	*English*
12. Mānattu vandē, madiyolanda ival pūcendē ! kānattu vandē, ival manam kaliyāda pucendō ! (mēlam)	12. O bee (flying in the) sky, this woman's intoxicated flower-ball,[1] O forest bee, is her flower-knot (so hard that it) won't melt ? (drum).
13. Āttule vālo nāttu, adi vāle nūleduttu, allikku itta māle avala matra māleyāce !	13. (I) planted plaintain in the river-bed, (and) made rope out of the stem, the garland which was placed on the woman, it proved a waste.[2]
14. Pacca manśal tattilēyam, pādasaram mējayile, en pāndiyanam pādayily, pāda saram aniyavanda, paśankiliyāl mūlyile.	14. The fresh turmeric[3] is on the plate alone, (and) the anklet on the table, my husband[4] is on the bier, (they) came to remove the anklet, (and) the parrot (self) is in the corner (weeping).[5]
15. Tanga podulangāi, śamokkum tangāl ingirukka, darmalōka tēr pārka ippōtānu palana menrāl.	15. The gold snake-gourd, to cook it there is my younger sister, looking at the juggernaut of *darmaloka*,[6] he says 'the journey is about to begin now.'
16. Enakku pattedakka tāmbalam, pattaduppu mōrkolimbu, pāndiyarum ingirindāl, pattumani yāgum, pattareyum pāsāgum.	16. For me the *tāmbāḷam*[7] with ten containers, (and) ten ovens of *mōrkolimbu*[8] if my husband were alive, it would be ten, (and) even the ten-thirty (train) would pass by.[9]

In the above song, the widow mourns how busy she would be, cooking, in those lucky old days, and how, now, time does not move at all.

17. In the following poem the widow mourns that she appears degraded and wretched in her own eyes.

Tamil.	*English*
Kadugu śirukulattāl, kandāngi mēngulattāl, kadugu śiruttadānāl, kannāti mēn kulyndēl.	Mustard is of a high caste, (my) sari is of a high caste,[10] the mustard is small, love's (self's) body has become disfigured.

The songs below are sung while the *Kodumbāvi* is being burnt on the third day. They tell us how the daughter (in her husband's house) heard, by wire, of her mother's illness, and how she found the mother dead when she reached the village. We note here the railway, the telegraph, and also that these women while away the noon playing cards !

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1 The bee is compared to the lover and the flowers in the hair-knot to the beloved.

2 Here again it is the widow who is mourning her fate. This warning is necessary as it seems to be otherwise at first sight.

3 Turmeric freshly dug up from the earth is rubbed over the body, and it is considered to be the sacred symbol of woman's earthly happiness.

4 The husband is frequently addressed as 'my pāndya', comparing him to the Rājās of Madura.

5 This pathetic song deals with the harrowing theme of the jewels, etc., being removed from the widow's person on the tenth day.

6 The widow here addresses her husband directly as he is about to leave the world. The juggernant of *darmolōka* has come to take him away.

7 A vessel with a number of containers to hold the various *pān* articles.

8 A hot dish prepared with buttermilk.

9 Note how the train has crept into even an ancient song.

10 Only means a good, costly *sari*, probably a silk one.

Tamil	English
18. Nān kālu mēl kālu pōṭṭu, kāyidangaḷ āḍupōdu, ammāḷukku tāyivīṭṭu kāyidanru tandiyale vandudu.	18. When I was playing cards with my one leg (stretched) upon another, that my mother was ill in her house, so came the wire.
19. Nānu aḷadu puḷḷy tūkāmal, avareḍal śollāmal, avinda myr kaṭṭāmal, anjumaṇi śeṭṭilale nān avasaramāi pōi śēndēn.	19. Without lifting up the crying baby (on the floor), without telling my husband, (and) without knotting up my loose hair, I went home in haste by the five o'clock shuttle (train).
20. Āse puravi aṇṇā, 'amma ennu śolli pōnāḷ?' mānatte kykāṭṭi, maratti neḷalgāṭṭi, kuḷatty jalamkkāṭṭi, amma kuyıl radam ēri pōnāḷ.	20. 'Dear *Anna*, what did mother tell before she died?' (Brother replies): '(She) showed the sky, (and) the tree-shadow, (and) pond-water, mother got into a cuckoo-chariot and (flew) away.'*

KĀḶIYAMMAN PAṬṬU

The following song is sung by women during the weeding of paddy fields (weeding is an exclusively feminine occupation). One woman leads the chorus and the others follow her. The song describes the routes taken by Kāḷi, the village goddess, in procession.

Tamil	English
Nanna nannām, (repeat three times more) oruvagy pūveḍuttu pūveḍuttu, swāmi kumbiḍa pōgaile,	Nanna nannām (repeat three times more), taking a certain kind of flower (and) going to salute the deity,
ellārum naḍakkuvaḷi muḷḷu muḷḷāi śorugudē,	the path where everyone walks, a thorn enters my feet,
kāḷiyamman naḍdakkuvaḷi pūngunjam katti vīsudē,	the path which Kāḷiyamman treads is festooned with fragrant flowers,
māvy eḍittavyttu, māntuḷiry donny tyttu,	keeping rice-flour[1] aside, (and) making leaf-cups from tender mango-leaves,
pūvy parittavyttu, pūntuḷiry donny tyttu,	plucking flowers (and) keeping them aside, and making leaf-cups from tender leaves,
nanna nannām (repeat three times more).	*nanna nannām* (repeat three times more).

MĀRIYAMMAN PĀṬṬU

Tamil	English
Orān karagamaḍi māriyamman tāyē,	It is a pot,[2] O, Māri, mother,
ōḍivaram pūnkaragam kanniyamma tāyē,	the beautiful pot will come running (to you), O, Māri, mother,
ānemēle śāmbarāṇi māriyamman tāyē,	frankincense on elephant's back, O, Māri, mother,

[1] One of the most common and peculiar modes of propitiation to Kāḷi and Māri in South India is known as the 'Māvaḷak.' Rice soaked in water is beaten to powder and mixed with sugar. The mixture is heaped up in a plate, a depression is scooped out in it, and *ghi* is poured into it. A cotton wick dipped in the *ghi* is lit. When the lamp goes out, the flour is eaten as *prasāda*.

[2] There is an intimate relation between the Karaga (pot) and worship of Māri and other village deities which deserves to be studied.

Tamil	*English*
amartivakkirē enre nōḍi, Māriyamman tāyē,	did I say I would keep, O Māri, mother?
oṭṭy mēle śāmbarāṇi māriyamman tāyē,	frankincense on a camel, O, Māri, mother,
oṭṭı vakkire innārōḍi māriyamman tāyē,	did I say I would paste, O, Māri, mother,
kottu kottai vālapalam māriyamman tāyē,	bunches of plaintains, O, Māri, mother,
konḍu paḍakire innārēḍi māriyamman tāyē,	did I say I would bring (and) offer, O, Māri, mother,
koleyōḍe tēngāigalam māriyamman tāyē,	bunches of cocoanuts, O, Māri, mother,
konḍu paḍekire innārōḍi māriyamman tāyē,	did I say I would bring (and) offer, O, Māri, mother,
koṭṭōḍe vettilayām māriyamman tāyē,	packet of betel, O, Māri, mother,
konḍu paḍekire innārōdi māriyam-mam tāyē,	did I say I would bring (and) offer, O, Māri, mother,
kunḍōḍe śakkareyām māriyamman tāyē,	basketful of sugar, O, Māri, mother,
konḍu paḍekire innārōḍi māriyamman tāyē?	did I say I would bring (and) offer, O, Māri, mother?

THE MOTHER OF ŚENJI HĪLL

The song below is addressed to the deity (female) on the top of a hill.

Tamil	*English*
Uccimale uyarnda male,	High-peaked hill, high hill,
uyarndirukkam śenji male,	the Śenji hill is high,
śenjiyamma tāyāre undan	O, mother of the Śenji hill,
śīr pāḍam nān marevēn.	I won't forget your sacred feet.

THE SONG OF SUBRAHMAṆYA

Subrahmaṇya is one of the most popular, if not the most popular, deity of the Tamilians, and the following song is addressed to him. The most celebrated shrine of Subrahmaṇya is without doubt the one on top of the Paḷni Hills, which lies on the Dindigul-Erode road. Incidentally, we may remark that it is common to find Subrahmaṇya temples on hill-tops.

Tamil	*English*
Erāda maletanile eruduranḍam tattaḷikka,	On the unclimbable hill, two bullocks are tottering (under a load),
pārāmal kyguḍuppāi palaṇi male vēlavanē,	immediately lend a helping hand, O, Vēlā[1] of the Palni Hill,
enne taly alagā, irakādu muttalaga,	(you) beauty, with oil-anointed head, (you) beauty with pearl-ears,
un vanna maḍimēle vandudaḍa ponśaraḍu.	on your beautiful lap is the golden chain.

Two lovers go to the Naṭarāja temple at Chidambaram for the *Ārudra Darśanam* (in the mouth of *dhanus*, *saggitarius*, Dec.-Jan., when the con-

[1] Vēlānḍi, vēlāyudhan, etc., are among the many names of Subrahmaṇya. The spear with which he is shown is the *Vēlāyudha*.

[2] The stone image of Subrahmaṇya as a boy (Muruga, again a favourite Tamil name) is daily anointed with oil, honey, etc.

Tamil	*English*
2. Ayyampēṭe tilly nāyakar nellūrar, angāḷamman kōvil engaḷ, kuḷa dyvam, mannavargaḷ pōṭṭrum śikkaḷ vaḷa nādary, anjivanangiyē kenji uḍanginō, nāgūr mirāsa......	2. Ayyampēṭe (place),[1] Chidambaram (place), Nellur (place), Angālamman is our family (*Kula*) deity, (the) wealthy lord of Śikkal whom (even) rulers praise, if we with fear, humility and cringing, bow to him, *Nāgūr mirāsa*. . . .
3. Sēle puḍavygaḷ, nīla vaḷavigaḷ, śingāramānodōr tanga valavigal, māleyim, puspamum vāngi tārēn vāḍi, vaḷḷi parāśatti, elliyammane pōṭi, nāgur mirāsa......	3. Salem saris, blue bangles, beautiful gold bangles, garlands, flowers, I will buy for you, come, (we) shall salute deity, *Parāśatti*, *Elliamma*,[2] *Nāgūr mirāsa*. . . . .
4. Illā allallā pakkiri kūṭangaḷ, ēttiye tottira pātiya śyvudan, śollalla enrume vēnḍi salām śydu, śōru vāḷanguvudam, pēru valanguvudam, nāgur mirāsa......	4. (the) fakir groups (shout) *illā*, *allalā*, (they) praise, pray and do pātiya,[3] (they) say *alla* (and) do *salaam*, (they) give food, and (they) give names, *Nāgūr mirāsa* . . . . .
5. Tangappaḍi kanḍum engengum tōnudu, tanga paḍumegaḷ engengum tōnudu, sangeyillamale tunda veḷakkagaḷ, tāyiyē āyiram tonudu pār, nāgur mirāsa.......	5. Two gold steps,[4] we see (them) every where, gold dolls, we see (them) everywhere, countless (bell-metal) lamps, (we see) thousand flames[5] burn in a flaming motion, *Nāgūr mirāsa* . . . . .

KANNIGAḶ PĀṬṬUGAḶ

The *Kannigaḷ pāṭṭugaḷ* are all sung on the third day of the Pongal festival—easily one of, if not the most important of the Tamil festivals. On the third day's morning, women folk, especially young girls, go to the mangrove where there are the seven stones representing the seven *Kannis*, and after worshipping the latter, stand in a circle, and sing the songs to the clapping of hands. Hence, these songs are also known by the name of *Kummi taṭṭara pāṭṭu*, which, rendered roughly into English, means, 'bowing (to the *Kanni*), clapping (hands) songs.' The women stand facing each other, and the palms of the opposite members come together, in a resounding clap, and there is perfect timing among the various singers. After every, clap, each bows down, to lift up the head once more and clap again. Assuredly, there are a good many varieties of the movement to which however, only the movie camera can do justice.

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1 He goes on describing the places of interest on the road to Nāgūr in Negapaṭam.

2 There is a temple to Elliamma in Negapatam.

3 The fakirs distribute sugar offered to the deity and this is called *pātiya*.

4 There are two gold steps in the Nāgūr temple.

5 People (especially those who are undertaking voyage to Singapore) vow to offer bell-metal lamps to this deity. These are thrown into the sea, and said to float back to Negapatam !

The *pongal* is a very old festival of the Tamilians, celebrating as it does the coming in of the new crops. And the songs sung there are certainly very old, though they have suffered many changes with time. They have been transmitted orally from generation to generation, a process which is certainly not conducive to preserve a record accurately.

The sample of *pongal* songs given below may be taken as authentic as I collected three versions, and they all agreed in the main.

The *Kannigaḷ pāṭṭugaḷ*, in addition to welcoming the *Kannis*, deal with almost everything under the sun. I think, that after the initial invocation to the *Kannis*, no restriction whatever is placed on the choice of subject matter. In them we find the father's sister's son (*attān*) mocked at, the story of deep hatred between the mother and daughter-in-law, lament at the loss of a fighting cock, the rebuilding of a piḷḷyyār temple, and even such a modern incident as the return of a lover who is a labourer in the rubber plantations of Burma. Obviously the religious tradition prevalent here has not been self-conscious enough to prescribe the mode, wording and theme of the *Kannigaḷ pāṭṭugaḷ* once for all.

Before we proceed further, we must note that the song is frequently repetitious and unintelligible. We get three or four lines painting a particular picture, or depicting a certain incident, and suddenly the thread snaps, and a new one is picked up. It is like going through a pack of snapshots, and one has, perforce, to make the utmost of every picture.

Now for a few words about the *Kannis*. Their names are not mentioned in the song. Their exact number is doubtful—in many places it is mentioned as 12, but in one we find a reference to the '7 sisters.' And printed literature, whatever there is of it, is no certain guide in the matter. For example Ziegenbalg tells us, "from this Śakti they derive nine other Śaktis called Nava-Śakti. Some say these are the consorts of Iśwara, Viṣṇu and Brahma; and others give them the following names: 1. Māriamma, 2. Ellamma, 3. Ankālamma, 4. Bhadrakāḷi, 5. Pīḍāri, 6. Cā- muṇḍi, 7. Durga, 8. Puranai, and 9. Pudakalai; the last two of which are Ayanār's wives."[1] But the Tamil Lexicon gives a different set of 7 sisters: Piramaṇi, Navayāni, Mākeśwari, Kaumāri, Vārāhi, Rudrāṇi, and Indrāṇi.

The songs themselves fail to throw light as to the identity of the *Kannis* worshipped. We get only two stray references, one to Pīḍāri, and another to the Mahākāḷi of Chidambaram.

The *Kannis* appear to live beyond the Seven Seas of the Hindu Purāṇās. And in the deep jungle which not even a sword or broomstick penetrates, a pair of horses is sacrificed to them.

The *Kanni* is a young girl, wearing the *pāvāḍy* or the *śittāḍy* and not *puḍavy* of the growing women. She has *lac* bangles on her wrists, and she has stuck flowers in her hair. She even sticks the *Kunḍumani* (*abrus precatorius*) tree, with roots, flowers and all, in her plait.

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1 Genealogy of South Indian Gods, by B. Ziegenbalg, translated into English by the Rev. G. J. Metzger, Madras, 1869, pp. 36-7.

Her arrival befits a goddess. As she progresses in her chariot, houses collapse, and it resembles a cyclone. On the way she loots towns. At Kolladam (about five miles from Chidambaram where the river Coleroon joins the sea) she sees a crane and eats it up; and a *bakka* bird which crosses her path shares the same fate.

The *Kannis* winnow the paddy of the villagers, pound it, remove the bran, and even parch it. (This indicates their relation to the newly harvested rice crop.) In one place they are referred to "as having come to satisfy all our desires." They possess young girls who weep and dance under the possession. The possessed girl, identified totally with the *Kanni*, is asked what she wants, and she names her desires on the satisfaction of which the deity leaves her. The worshippers ask the possessing *Kanni* whether she wants *jilebis*, bundles of sugarcane, turmeric, flowers, combs, mirrors, lamps and *māvalak*. One of the songs mention the sacrifice of a cat and dog to Pīḍāri.

The *Kanni* is given a bath in the right royal way. The devotees tell her that they will remove the road-thorns for her, and greet her with sandal paste, etc.

The *Kanni* does not appear to be a pleasant deity. She is fault-finding, deceitful, and even referred to as a 'murderess.' Only in one short song do we find a pleasant picture of her, playing with the Paryyan girls.

The *Kannis* say in one of the songs given below, that they came in search of the '*Maharaja's* door,' and this allusion is not very clear. We get a reference to Indrāṇi having a bath in heaven, and the Mahākāḷi of Chidambaram, 'who has studied the law,' also being given a bath.

The *Attān* (father's sister's son) is going out, on a very rainy day, dressed in his best, with a gold-laced *dhoti*, etc., and his mother's brother's daughters, who are watching him, make fun of him and laugh at him. This joking relationship taken together with the fact that two-way cross cousin-marriage is widely prevalent in Tamil land is an important sociological fact.

The reference to the "Śeṭṭi's son, the sinner," who has left his sweetheart behind, and gone to Burma in search of his livelihood gives us a glimpse of the psychological effects of a social—one may even call it, more accurately, economic—process. The effects of the widespread emigration of the Tamil Non-Brāhmin population to Burma, Ceylon, etc., deserve to be studied sociologically.

We get a reference to a decaying Piḷḷyyār temple, and of the construction of a new temple to him by raising a public fund. Piḷḷyyār enters the temple, but his sweetheart(?) closes the door on him, and he begs to be let out. The comic side of Piḷḷyyār's personality is prominent here.

One very important song mentions the fight between Kāttavarāyan, the son of Māri (confused with Subrahmaṇya, who is Viṣṇu's son-inlaw), and the *Kannis*. Kāttān is aided by the black magic of Śinnān of Malabar (incidentally, one of Māri's names is Mōḍi which means black magic) in his fight against *Kanni*. The village girls are against Kāttavarāyan, and wish to see him disgraced and hanged. Have we here, the recording of a social protest against black magic (coming from Mala-

bar) which was being used for anti-social ends ? In this fight against an anti-social force, *Kanni* is on the side of the pro-social force.

A long tale describes the fight between a sadist mother-in-law and her daughter-in-law, and how in the end the latter commits suicide. The girl's elder brother learns of his sister's death, puts the mother-in-law to disgrace, and finally throws her into a burning lime-kiln. He also hacks the other daughters-in-law who probably aided in the conspiracy against his sister. Why should the *brother* revenge on behalf of his sister ? From the point of view of social psychology, this tale is significant.

There is a pathetic tale about a widow who lacks the money to bury her husband, and to buy food for herself. Another in which a wife hates her husband, and hopes for his death so that she may go back to her own parental home and marry another, is interesting.

Some songs appear to be utterly irrelevant, *viz.*, where a girl wants to climb the frail and dwarfish *tumbe* plant, and where a question is asked about a bowl floating in a stream.

KANNIGAḶ PĀṬṬUGAḶ—1

Tamil	*English*
Inda teruvile āru kanni, anda teruvile āru kannḷ,	Six *Kannis* in this street, six girls in that street,
nalla nalla kanni vāśalile, nāli nelly kanni kāya pōṭṭāl,	good, good, *Kanni* at the door, *Kanni* spread (before the door) a *nāli*[1] of paddy to dry,
kuṭṭikittāḷ, kanni, kolicigiṭṭāḷ,	*Kanni* pounded (the paddy), winnowed it,
kūḍāda peṇgaḷollā kūṭṭigiṭṭāḷ	and mixed with girls who were not her friends,
māḍu tingum paryyan vāśalile, kuṭṭa kulappi. kuru mēḷam śēvicci,	at the door of the cow-eating[2] paryyan, pound, churn and beat the paryyan drum,
kūttāḍi pongamēle vārā kanni yāraḍi?	who's the *Kanni* who possessed the girls?[3]
ēlyyō ō manasu erangaleyō eḷḷaḷaum ?	are you (*Kanni*) poor (in sympathy), does not your mind melt even the size of a gingelly ?
kallōḍi yun manasu karyyileyō eḷḷaḷavum?	is your mind a stone that it does not melt even the size of a gingelly ?
vēḷḷātām kunḍumaṇi vērōḍa puvōda,	the *kunḍumani*[4] (tree) available on the banks of white-river, with root and flower,
kannāra vīra śeḍy pōṭṭāḍi kanniyā,	the *Kanni* will have the heroic pigtail of the coppersmith (woman),

[1] One fourth of a *Paḍi*.

[2] Paryyans eat the carcase of cows.

[3] One of the traits of the *Kanni* is possessing young girls, who dance, and prophesy under the possession.

[4] (Abrus precatorius), *kundumaṇi*, beautiful red and black seed found in the pods of the tree. The seed is used as a weight by goldsmiths. The *Kanni* decorates her plait with the seed, flower and root of this plant, (or does she stick the entire plant in her hair ?).

Tamil	*English*
karapattān kuṇḍumaṇi kāi vōḍa pūvōḍa,	the *kuṇḍumaṇi* (tree) on the banks of the black-river, with its flowers and root,
kannāra vīra śeḍy pōṭṭāḍi kanniā.	the *Kanni* will have the heroic pigtail of the coppersmith,
śittāḍy kaṭṭi śeruva maḍi gōli,	tying the *śittādy*, and holding the small lap,[1]
śembarattān pū parici vārāḍi kanniā.	plucking the red flower, the *Kanni* will come.
ēlu kaḍal tāṇḍi eḍuttu vandāḷ tāmbary	crossing the seven seas, she brought lotus,
tāmbary pūvāl konjam tāmaśangaḷ śanrudu,	there was a little delay because of the lotus,
mēgatty yaḍakkavē milāru pala tuḷukkavē,	like clouds covering up the sky, many *milaru*[2] plants sprouted,
māmāsi polavē, śuldāḍi kanniā.	like immense clouds, the *Kanni* comes in an encircling movement.
kīlkāt aḍikkavē, kiḷygaḷ pala tuḷukkavē,	the east wind blowing, many branches have sprouted,
śinna elayilē śiruduḷi paṭṭāyō,	(like) small drops falling on small leaves,
śivaloli mulangiḍa vārāḍi kanniā,	as the name of Śiva is sounded, the *Kanni* comes.
alli elayilē aruḍuḷi paṭṭā pōle,	like rare drops on the lily leaves,
kannia vandadum kaḍala parapurā.	gram is spread before the house to receive the *Kanni*,
kaḍe kuṭṭi tangācci śēlekki aḷugirāḷ,	the youngest *tangy* (of the *Kannis*) weeps for a sari,
oḷḷu vaṇṇam eḍuttudum eḍumum koraccc yannu,	when the gingelly-coloured sari (was shown her), (saying) the width was not enough,
irandāḍi pūmēle.	she sat on a flower.
pākku vaṇṇam eḍuttudum, padungurāle kanniā,	the *Kanni* covers herself with an areca-nut coloured sari,
mayilkaṇ śēly maḍiyoḍe eḍuttudum,	the peacock-feather-design sari, the *madi*[3] brought,
marendu ponāḷ kanniā,	the *Kanni* went away forgetting it.
pattu paṇattilē ūśi vaṇṇam eḍuttudum, parandu pōnāḷ kanniā.	with ten *panams* a needle-coloured sari was bought, (but) the *Kanni* flew away.
śāyam koracennu sānjā guḍimēle,	complaining that the colour was not deep, she leaned against the temple,
ēnḍi ēnḍi kanniā inneram tāmaśam?	why, why, *Kanni*, you delayed so long?
katti noḷyyāda karuvēlam kāṭṭile,	in the black *vēlam*-tree[4] forest which a sword cannot penetrate,
iṭṭi noḷyyāda elly kaḍanda kāṭṭile,	in the limitless forest which a spear cannot penetrate,
raṭṭa gudure pōṭṭu veṭṭurāḍi kanniā.	the *Kanni* cuts down a brace of horses.[5]

[1] The sari tied by grown up women is called *ādy* or *puḍavy*, whereas the sari tied by a young girl is called *śittādy*, or small sari. The lap refers to the cloth of the waist which is folded upon itself, and with either end tucked in at the waist, to make a sort of receptacle. The *Kanni* is a virgin, and probably not yet come of age.

[2] Same as *Karuvapile.*

[3] *Maḍi*, two or four saries, each one of them 18 cubits long, bought at a time.

[4] Acacia arabica.

[5] The *Kannis'* home appears to be an impenetrable forest across the seven seas of Hindu mythology. And they love bloody offerings.

Tamil	*English*
pākaṭṭiyum karaṇḍavamum pāi mēle vacciputṭu,	the nut-cutter, chunambox,[1] placing them on a mat,
pākkāḍa pōrāḍi paligāra kanniā,	she goes away without a look back, the murderess *Kanni*.
śuṇṇāmbu karaṇḍavamum tinna mēle vacciputṭu,	chunam, chunam-box, placing them on the pial,
pākkāḍa pōrāḍi paligāra kanniā.	she goes away without a look back, the murderess *Kanni*.
śollāde pōrāḍi śūdugāra kanniā.	goes away without saying (a word), the deceitful *Kanni*;
kūvāme pōrāḍi kurykuram *kanniā*.	goes away without a sound, the carping *Kanni*.
tenna marattanḍē tēnunḍu pālunḍu,	in the cocoanut tree, there's honey, there's milk,
tittikka palamunḍu tavaṭṭāda kani unḍu,	there are sweet fruits, fruits which one always desires.
vāly marattanḍe ennaḍi kanniyā, vāly palamunḍu,	in the plantain tree, my *Kanni*, there are plantain fruits,
vālkkēṭṭa tēn unḍu,	there's honey to suit the taste,
iga peruma vārāḷe, ponga peruma vārāḷe,	the big one comes, the gold deity comes.
kanni kaliyā pongaḷe kākṣi koḷḷa vārāḷe,	she comes to present herself to girls who have not reached puberty,
nellallām tavaḍaḍacci vārāḍı kanniā,	she comes after removing the bran from rice,
pōrāḍi kanniā pori poricci pōrāḷe	the *Kanni* goes, she goes after frying paddy.
arakku valyyaly āyiram aṇindugonḍu,	wearing a thousand *lac* bangles,
aśy yōḍe vārāḍi annambōle kanniā,	swan-like, the *Kanni* comes with desire.
tanga vaḷyyagaḷy, dayāḷamā aṇindugonḍu,	gold bangles, wearing them with kindness,
tangeyum akkāḷum tanitaniya vārāḍi.	the *tangys* and *akkas* (the *Kannis*) come one by one,
śimān magaḷaḍi śelvaman ēḷpērum,	the rich man's pet daughters, the seven persons,[2]
śerappuḍan vārāḍi.	come with all the paraphernalia.
śēdurāman tangacci mōḷa tāḷa mulange,	Śēdurāma's[3] *tangy*, when drums and cymbals are sounding,
mudigiye vārāḍi.	she comes soon.
pattarymāttu paśumangy vārādi,	the sacred and good women will come,
nattu mukutti pōṭṭu nāṭṭiyam paṇnikonḍu,	wearing the *nat*[4] and nose-screw, and dancing,
kanḍaśerappaḷi kalittile aṇindugondu,	wearing the anklet (silver), *kolasu*,[5] she will come soon,
āśeyollām tīrka vārāḍi kanniā.	she comes to fufil all our desires.

[1] Which the village girls have offered in welcome.

[2] We get seven as the number of *Kannis* here instead of twelve, with which the song began.

[3] According to the *Śaiva Purāṇa*, Pārvati is supposed to be the younger sister of Rāma. Thus all the Śaktis are his sisters. Accordingly the Śaivites call Govindarāja Perumāḷ (Rāma), *Māmā* or maternal uncle.

[4] The nose ornament so common in Maharāṣṭra finds a mention here. We may note here that the *nat* has completely disappeared from the Tamilian South. Brāhmin ladies used to wear it formerly, and I do not know, apart from the reference to it here, whether the Non-Brāhmins used it.

[5] *Kolaṣu*, anklet like a chain, and decorated with small, hollow silver beads.

Tamil	*English*
kokku parakkāda koḷḷadattā mūlayile,	the crane which cannot fly, near Koḷḷaḍam[1]
kūḍi vārāḷe kuruganni ēlu pērum.	the seven Koraca[2] sisters will come together,
vakkā parakkāda vāṇagiri mēṭṭumele,	the *bakka* which cannot fly, near Vāṇagiri knoll,
puḷḷy ya āṭṭi pulal pōre vārāḷe.	She comes like a cyclone which shakes the house.
karaḍi urungu vanam, kāṭṭēri kūḍu vanam,	the jungle where the bear sleeps, where the devil Kāṭṭēri lives,
śiruttegaḷ tūnga vanam, śirupuli tūngu vanam,	where cheetahs sleep where tiger cubs sleep,
śennāi karaḍi puli śengaṭṭam pōḍu vanam.	the jungle where the red-dog, bear, tiger play.
ikki nolyyāda irunda vanam kaḍandu,	crossing the black-forest which a broom stick cannot penetrate,
āśeyellā tīrtupōga anbāga vārāḷe,	to get her desires satisfied, she comes with love.
nalla nalla kanni vārāḷaḍi nāli nella kāya pōṭṭu,	good, good *Kannis* will come spreading ānali of paddy to dry,
pāttu kōḍiyē kanni pāriya paṭṭaṇam pōyı vārēn,	you look after (?) *Kanṇi*, I am going to pāriapaṭṭaṇam,[3]
andikki ranḍu kada veṭṭikki vā,	come, (I will) cut two goats (for you) in the evening,
alagāna peṇgaḷeyam kūṭṭikki vā.	come along with beautiful girls.
śandikki ranḍu kaḍa veṭṭıkki vā,	come, (I will) cut two goats (for you) in the evening,
śamynda peṇgaḷeyum kūṭṭikki vā,	come with girls who have attained puberty.
paṭṭaṇam parigoḍuttu vārāḍi kanni,	the *Kanni* comes after looting the town,
pamby mulangivara vārāḍi kanniā,	she will come to the beating of the drum,
vārāḍi kanniyā vanduviṭṭāḷ kanniā,	the *Kanni* will come, the *Kanni* has come,
vaṇangā ponga mēle vanḍupuṭṭāḷ kanniā	she has come down (in anger) on the unbowing girls.
vandu viṭṭa kanniā, ēnḍi ēnḍi kanniā tēmbi tēmbi aluvure ?	the *Kanni* is come, why, why, *Kanni*, you weep, sobbing, sobbing?[4]
ennā kory cennu śolluḍi kanniā,	tell (us) what is lacking, *Kanni*.
ēmātti pōvāde ninnu śollaḍi kanniā,	do not go away deceiving (us), stop (and) tell us (what you want).
ennā kuryśalendu śollēnḍi kanniā,	tell (us) what is lacking, *Kanni*.
inbamā valicci ellāmum vykkurēn.	we will secure everything, and place them (for you) with love.
ēnḍi ēnḍi kanniā, tēmbi aluvurē?	why, why, *Kanni*, you weep, sobbing, sobbing?
ennā koreyennu śollēnḍi kanniā,	tell us what is lacking, *Kanni* ?
innippu koraca lennu śollēnḍi kanniā,	tell us if sweets are lacking, *Kanni*,

1 Koḷḷaḍam village, a few miles from Chidambaram. Further on we find that the *Kanni* eats up the crane and *bakkabird*.

2 It may either refer to caste of the *Kannis* or to their deceptive nature.

This line is wrong. In fact, it is the *Kanni*, who says that she is going to Pāriyāpaṭṭaṇam.

4 The *Kanni* has possessed one of the village girls, and she is weeping hysterically. Often, the possessed girl also starts dancing. The possessed woman is identified with the *Kanni*, and she is asked to mention what she likes to have. The *Kanni* is said to leave the particular girl only after the things she wants are given to her.

Tamil	*English*
jilēppi āyiram śoyadāmo vakkirē,	(then) we will keep a thousand *jilēbis* for you.
karumbu koracalennu śollēndi kanniā,	tell us if sugarcane is lacking, *Kanni*,
karumbu kaṭṭōḍe āyiram vāngi vakkirē,	(then) we will keep a thousand bundles of sugarcane.
ēndi ēndi kanniā tēmbi tēmbi a*l*uvure ?	why, why, *Kanni*, you weep, sobbing, sobbing?
manśa kurycennu śolludi *kannia*,	(tell us) if turmeric is lacking, *Kanni*,
manśaḷim āyiram vāngi vakkirē.	we will keep a thousand turmeric bits (for you).
pūvu kurycannu śolluḍi kanniā,	tell us if flowers are lacking, *Kanni*,
pūvule āyiram vāngi vakkire.	we will keep a thousand flowers for you.
dīpam kurycennu śolluḍi kanniā.	tell us if lamps are lacking, *Kanni*,
dīpattil āyiram vāngi vakkirē.	we will keep a thousand lamps for you.
śīppu kurycennu śolluḍi kanniā.	tell us if combs are lacking *Kanni*,
śīppile āyiram vāng i vakkirē.	we will keep a thousand combs for you.
ēndi ēndi kanniā tēmbi tēmbi a*l*uvurē ?	why, why, *Kanni* you weep; sobbing, sobbing ?
kannāḍi kurycennu olluḍi śkanniā.	tell us if mirrors are lacking, *Kanni*,
kannāḍi āyiram vāngi vakkirē.	we will keep a thousand mirrors for you.
māly kurycennu śolluḍi kanniā.	tell us if garlands are lacking, *Kanni*,
mālayim āyiram vāngi vakkire.	we will keep a thousand garlands for you.
arakku mōdiram tirapi pōṭṭāpōle,	like putting on a *lac* ring,
namba āśe yellām tirtu vykka vārā*ḷ*.	she comes to fulfil all our desires.
pāḍuvumē, ini āḍuvumē,	we shall sing, hereafter we shall play,
ini manda kare mēle vily yāḍuvōm !	hereafter we shall play on the sward (where cows graze).
manda gary tēya, maṉ mēḍu tēya, tēya,	as the sward lessens, as the sand-heap lessens,
kaṭṭāndarymēl kylāyam tēya, tēya,	on the plain ground, *kailasam* lessens, lessens,
vakkā parakkudu vaṉṉagiri mēḍeye,	on the Vaṉṉagiri knoll the *bakka* flies,
vakkā parigoḍuttu vārāḍi kannia.	the *Kanni* comes (here) after finishing it.
kokku parakkadu kolladattā muly yilē,	a crane flies in the Koḷḷaḍam corner,
kokku parigoḍuttu vārāḍi kannia.	the *Kanni* comes (here) after finishing it.
ura kadu vaḍacci, oru mēḷam koṭṭiyē,	closing the village gate,[1] (and) beating a drum,
vārāḷe kanniā vaṉangūda peṉgaḷ, mēle,	the *Kanni* comes on the unbowing girls;
ēndi, ēndi, kannia, tēmbi, tēmbi, a*l*uvurē?	why, why, *Kanni*, you weep sobbing. sobbing ?
ennā endu śolluḍi engula kanniā?	tell us what's (the matter), *Kanni* of our *kula*,[2]
nādanḍi kanniā, vyyāpuri pōrēn.	I am the *Kanni* going to Vyyāpuri.
vyyāpuri vanam pārka pōriyō ?	are you going to see the jungle of Vyyāpuri?
vādaḍa ponga mēle śudāḍu pōriyā?	are you going to deceive the girls who argue with you?
śīyāḷi ammanuḍa valakkāḍa pōriyō?	are you going to quarrel with Śīyāḷi Amman?[3]
āttule pōra pōra arukanśeṭṭi yārōḍi?	whose is the bowl floating away in the river?

[1] Probably the villagers are closing the gates against the *Kannis*. Their attitude towards the *Kannis* is apparently not wholly one of love.

[2] *Kula* is used here to mean one's own, or belonging to one's caste. The possessed girl replies that she is going to Vyyapuri.

[3] Literally, the 'mother of Śīyāḷi,' refers to the deity of the place.

Tamil	*English*
adu namba tangacci ānḍa panḍam pōvadu.	that is the one which our *tangy*[1] inherited from her ancestors.
va*l*iyile tanniyā irukkudu, vārāde pōvāde,	there's water on your way (tous), don't go away without coming (to us),
vanamgiḍuve kanniā,	I will bow to you, *Kanni*.
va*l*i tanni erettu tārēn, vandu pōḍī kanniā.	I shall bail out the water on the way, come, O, *Kanni*,
va*l*ile muḷḷennu vārāde pōrāde kanniā,	don't stay away because of the thorns on the way,
vaḷi muḷḷu nīkkiḍuvēn vandu pōḍi kanniā,	I will remove the road thorns, you come, *Kanni*,[2]
tumby pū parikka tumbe mēle ērurēn,	to pluck the *tumbe* flowers, I will climb the tree,
tumbe tuvaḷudu kydāḍi nāciyā.	the *tumbe* tree shakes, extend your hand, woman,
kallōḍi yun manadu kareyalyyō eḷ aḷavum.	your mind is a stone, it has not melted, even the size of a gingelly,
iḷambōḍi yun manadu irangaleyō eḷ aḷavum,	your mind is iron, it has not melted even the size of a gingelly,
śembarattām pūparicci vārāḍi kanniā,	she comes here, plucking red flowers,
pāvāḍy kaṭṭi parakka maḍigōli,	tying the *pāvāḍy*,[3] (and) with a big lap,
pāvāṭṭa pū paricci vārāle kanniā,	putting flowers on her lap, the *Kanni* will come.
kaḍaly ku*l*appurā kaḍa kuṭṭi tangacci,	she churns the sea, the youngest (and) last *tangy*,
śēlykki a*l*uvura, minnāttā gunḍumani vērōḍe puvōḍe,	she weeps for a sari; the *kunḍumaṇi* of (river) *minnār* with flowers, roots,
veḷḷāḷa vīraśeḍy pōṭṭāḍi kanniā.	she has the brave pig tail of the Veḷḷāla (woman),
śeṭṭam paḍicava tilly māgālikku,	to the *māhākāḷi* of Childambaram who has studied the law,
taṭṭiṭṭu odutta tangattanni, tanga nākkāli mēle ēri,	keep a plate in the golden, flowering, water, (and) seat on a gold table,
ava tayilam tēci, tale mu*l*agi,	massage her head with *tailam*,[4] bathe her head,
vennīr arukkāda tilly mākāḷikku veyil uruttady pārungaḍi.	the *mahākāḷi* of Chidambaram cannot bear scolding water, she (also) cannot bear the sun,
konḍe peruttava tilly mākāḷikku	to the *mahākāḷi* with the big hair-knot,
konḍu pōra kūḍe mallige pū.	she carries a basketful of jasmine flowers.
kyyil uḍukkyyum vībūdi py konḍu,	(the devotee) carrying a *vibhūti* bag in her small hand,
ka*l*uttil rudrākṣi māle punḍu vykunḍa puśy śyginra,	having the rudrākṣi beads in her neck, to do the *vykunḍa pūja*,[5]

1 Probably the reference is to the *Kannis' tangy*.

2 Small shrub with white flowers sacred to Śiva. Climbing a *tumbe* tree is an old joke, describing one who is a midget.

3 *Pāvāḍy* indicates that the *Kanni* is not even ten years of age, as it is worn even earlier than the *śittāḍy*.

4 The habit of taking an 'oil-bath' once a week, and on auspicious occasions, is very common all over South India. Here the *Kanni* is being given an 'oil-bath' in the right royal style.

5 The use of the word *Vykunṭa* here points to the absence of a clear-cut distinction between Śaivism and Vaiṣṇavism. Strictly speaking, *Vykunṭa* is used only with reference to Viṣṇu.

Tamil	*English*
dīkśitar śyginra puśyyai vandu vaṇangi pārungaḍi.	come, women, to see the *pūja* which the *dīkṣitar*[1] is doing.
veḷḷikkilamy yudyyittile,	on Friday morning,
anda vēdam paḍikkira nālyyile,	at the time when the beautiful *vēda* is studied,
nalla lagginam tannil rāvaṇam pēśura vēḷyyile,	at an auspicious hour, when Rāvaṇa speaks,
rāṇi indrāṇi ōḍi vandu viḷakkam kuḍatty viḷakkuminna,	queen Indrāṇi came arunning (and) asked (me?) to clean the *viḷakku kuḍam.*[2]
vennīru vykka kaḍāram, nalla vēdu puḍikka vaḷḷi śombu,	keep the cauldron for boiling water, (and) a silver vessel to hold steam,
palameḍukkavē tāmbaāḷam, pākku muli kiḷānjiamām,	(keep) the betel-nut tray, betel (and) arecanut,
paḷa paḷa mennum paṭṭuḍatti,	tying a silksari which shines *paḷa, paḷa,*
mānattu rāśāve mīnnaḍātti,	making the king of the skies (Indra?) walk ahead,
ingida māna marukolandu nīnga eppōdum vykkira vāḍikeyā ?	is it always your custom to keep good *marukolandu* ?[3]
vaḍakke pātta maccigalām,	houses facing the north,
nalla vanrappā vanna talygāṇi,	good mat (and) good pillow,
saḍa saḍa mennu maly pēya,	as the rain beat with a *śada śada* noise,
nalla śālava taṇṇi aly pāya,	as the good gutter-water was breaking into waves,
śātta kaḍukkan attānukku,	the *attān*[4] who is wearing *śātta kadukku* (earrings),
śaragi minnele pārangaḍī,	look at the shine of his gold lace,
muḍigaṭṭina muḍi pārangaḍī,	look at his firmly-tied hair-knot,
nalla mōśakkārane pārangaḍī,	look at the deceitful fellow,
muḍa muḍa menra maly pēya,	when the rain beat (with the noise) *muḍa, muḍa,*
nalla mōśakkāra attānikku,	the deceitful *attān,*
muragu minnele pārangaḍī,	look at the shine of his *murugu* (ear-ornament)
śura paḍandady pārangaḍī,	look how the *śorakka*[5] creeper spreads,
śura suṭṭila paḍandandy pārangaḍī,	look how it comes round and round
sogasukāra attānikku,	this beautiful, fashionable, *attān,*
murukku mīśyyai pārangaḍi.	look at his twirled moustache.
kalar tirukkalām , kambali neyalām,	(you can) twist rope (from it), (you can) weave a blanket,
tiruvaṇṇāmaly rāśavikku ulukku maram pōḍalām.	(you can) make the *ulukku*[6] tree for the *rājā* of Tiruvaṇṇāmaly.
poricca mīnyyum tinnariyār,	(the *attān*) has never eaten fried fish,
nalla ponigina śōṭrukku mīnariyār,	he does not know (the taste of) fish with well-boiled rice.

[1] Brāhmin priest.

[2] Pot containing ghee or oil with an immense cotton wick trailing into the depths. The wick burns for days.

[3] *Marukoḷandu* is a hedge plant common in South India. It has fragrant leaves, of which the Ādi-Dravida (Paryyan) girls are very fond, and with which they decorate the plait.

[4] *Attān* is the father's sister's son. He is joked at in the following lines. It points to the prevalence of joking relations with one's (W.S.) father's sister's son. The *Attān* has dressed himself in his best, on a rainy day, and his mother's brother's daughters, who are watching him, poke fun at him.

[5] *Śorakka,* the gourd from which the sanyasi's calabash is made.

[6] The *ulukka maram* is planted before temples, and someone climbs it and shakes it during festivals.

Tamil	*English*
oru kaṭṭu karumbā,	one bundle of sugarcane, .
onnuku onnālāyiramā,	one for every one thousand,
anda nāṭṭu karumbu.	that country sugar cane.
parangi ēttu kappalily	in the ship which Europeans climb,
anda śeṭṭimaga pādagan eppō varuvārō ?	when does the sinner, the Śeṭṭi's son return ?
munḍiri śārāyam durymagan,	cashew-nut arrack (for the) European,
munnūru kōli muṭṭy konḍu vārān kāṭṭi.	if 300 eggs are not given,
durymavan pōṭṭi śaidārō ?	will the (European) permit (the Śeṭṭi's sòn to come home) ?[1]
Piḷḷdyyār, piḷḷyyār, avarengeyō piḷḷyyār,	Ganesa, Ganesa, where is he ?
engeyum tēḍipātēn, averengeyō pil-ḷyyār,	I searched everywhere, where is he ?
vāḍiyō teruvile valakkāḍuva piḷḷyyār,	Ganesa who picked up a quarrel in the street ?
angeyum pōyi pāttēn, engeyō piḷḷyyār,	I searched even there, where is he ?
piḷḷyyār manḍapam piranji kaḍakku kummu,	Ganesa's *mantap* is in ruins,
kāśāle uḍugaṭṭurā, karyyam piḍikku minnā,	(they) are building a house (for Ganesa) with money, thinking that white ants will eat up,
ponnāle uḍugaṭṭi pōyi pugundār piḷḷyyār,	a gold house is built. Ganesa entered it,
kadavy tara pōyi pugunda pillyyār,	Ganesa who went in tried to open the door,[2]
pon mayilē kadavyttera, kāmākṣi kadavyttera,	(shouted) my gold peahen, open the door, Kāmākṣi, open the door,
en kanmaṇiyō kadavyttera, en pon-nākṣi kadavyttera,	mydarling, open the door, my gold eye, open the door,
en pon mayile kadavyttera.	my gold peahen, open the door.
kiḍugiḍu marudeyile,	in noisy Madura,[3]
nunḍi kiṭṭana sāmi,	lame Kriṣṇa swāmi,
oruvaram ariyāde,	unknown to anyone,
onbadu pengaḷy kannam iṭṭār.	stole nine girls.
kanḍu piḍica viṭṭu, nunḍi kaṭṭila,	discovered (and) caught, to a lame cot,
kāla kaṭṭi puṭṭa,	his leg was tied.
śaṭṭiye aḍupule vacci,	keeping the pot on the stone,
ottula nonḍi varakkam puḍicāru,	he fermented his lame leg with hot water.
śāvaladu śāval, nan vaḷatta śāval,	the cock, cock, the cock[4] that I reared up,

[1] The woman's lover, the Śeṭṭi's son, went away, years ago to Burma, as a labourer. The girl wonders when he is going to return. In this connection, it may be noted, that the labourers had to pay the white planter a fixed quantity of whisky, etc., to be permitted to return home—at least this is the belief that prevails among the people. It appears the white planter often demanded more than the fixed amount to release the labourer.

[2] The old temple of Piḷḷyyār is a heap of ruins, so by a public subscription a new one is raised. Piḷḷyyār enters it, but (folksong here gives him a sweetheart) his sweetheart closes the door on him from outside.

[3] Madura, the Pānḍyan capital, was always a noisy town.

[4] Cock fighting was a favourite sport in days of yore (especially, during the *Pongal*), and here is the lament of a man who has lost his pet cock, the hero of many a fight on the village green.

Tamil	*English*
śāval pōnāl nān pilyyēn śāmi gurunāda,	if the cock is gone, I won't survive the loss, O, Lord.
mandyyile mēnji varum, maṉuvā mani śāval,	the cock (used to) come home properly after a round (in search of tit-bits) in the sward,
śāval pōnāl nān pilyyēn sāmi gurunāda,	if the cock is gone, I won't survive the loss, O, Lord.
toṭṭigaṭṭi tālāṭṭi, nān vaḷatta śāval,	(I made) a cradle for it, sang a lullaby—thus did I bring it up.
nān vaḷatta śāval tanny piḍittu koṇḍavaḷāro,	I don't know who's the person that has caught it,
tulttippū varaṉamuḷḷa toresāmi śāval,	having the colour of *tutti* flower, the English cock,[1]
toresāmi śāval tanny śuḍuśeyidavaḷ-ārō.	who is it that has deceived me of my English cock ?
oru moḷavu tira molavu,	one pepper, good pepper,
ōranga nāḍu, vygāśi māsam,	the land of Śrirangam, month of *Vyyāśi*[2]
vandu kenda veḷi nādu,	in the barren land,
andāṇḍa kappaly indāṇḍu taḷḷi,	the boat on the other bank pushed into this,
ōḍara taṇṇile nangūram pāci,	casting the anchor in running water,
orupuramai kappaly karedanile śērka,	to push the boat to the bank,
vēdavallitāyār kaḍakṣattāle,	with the kindness of Vedavali (Lakṣmi)
vēgamuḍan kappal vandu śērndu-dayyā,	the boat reached this side quickly,
ēlēlō, ēlēlō, ayalēśa.	*ēlēlō ēlēlō, ayalēśa !*
mēlatteruvile vytturuku,	In the upper street, *mōḍi*[3] is kept,
medi eḍukkāde endi vandai kanniā?	O, *Kanni*, why have you come without removing the *mōḍi* ?
māyōn marumaganām, māripuḷḷy kāttāne,	Viṣṇu's nephew (sister's son), Kātta-vārāyan, the son of Māri,[3]
śirikkavakkiṉam, śelavugaḷe vāngaṉam	he should be disgraced, (and) made to pay the expenses,[4]
kāmākṣi maganyyum, kaṇḍavar śirikkiṉam,	the son of Kāmākṣi,[5] everyone should laugh at him,
kykoṭṭi nagekkaṉam,	(everyone should) clap her hands, and laugh (at him),
maleyāle śiṉṉāny maṇḍalam śirikkiṉam	Śinna of Malayāḷam, the world should laugh at him,

1 Probably it was bought from an Englishman, or its colour was red.

2 The song is sung by the supporters of *Kanni* against Kāttavarāyan, the son of Māri. Kāttavarāyan is aided in his fight for supremacy against the *Kanni*, by Śinnān, a Malabar magician. And *mōḍi* is a form of magic in which one magician throws a challenge to another, *e.g.*, he will ask the other to touch some stone into which he has infused magic. If the other is able to touch it, he wins. There are often public displays of *mōdi* in which the combatant magicians bleed, swoon, etc., through the magic of the opponent. Here *Kanni* has not accepted Kāttavarāyan's challenge.

3 We have mentioned before that Viṣṇu is considered the brother of Pārvati, and as all forms of Śakti are supposed to be Pārvati, he becomes material uncle to Kāttavarayan. Here Subrahmaṇya, Pārvati's son, is confused with Kāttavarāyan, and abused.

4 Expenses have been incurred to counteract Kāttavarāyan's *mōḍi*. So he is to be made to pay them.

5 One of the names of Pārvaṭi. Kāttavarāyan is confused with Subrahmaṇya, the younger son of Śiva.

Tamil	*English*
mahimeye kāṭṭaṇam.	the greatness (*mahime* of *Kanni*) should be shown him.
śeṭṭi maganyyum, śirkulyya śeyyaṇam,	the Śeṭṭi's son[1] should be disgraced,
teru śirikka paṇṇaṇam.	the (whole) street should laugh at him.
pārpāra peṇṇale bayamillāmal toṭṭāṇḍi.	(Kāttavarāyan) touched the Brāhmin girls without fear,[2]
āriya peṇṇyyum, alakṣamā toṭṭāṇḍi,	the Aryan girl he touched disrespectfully,
kirukku puḍicavaṇḍi, kiḷavaḍam pōṭavaṇḍi,	the eccentric fellow, who put on the old man's disguise,[3]
karpuḍeya mangeyare karpe aḷapāṇḍi,	he ruins chaste woman,
śinnānodaviyāle jagatte meraṭurāṇḍi,	(Kāttavarāyan) is frightening the world with the aid of Śinnān,
kaipile ēttaṇum, kaṇḍavar śirikkiṇum,	(he should be) sent to the gallows, (and) everyone should laugh (at him).
appōdu terīmaḍi avanoḍeya vaṇḍavāḷam,	then only will you know how hollow he is,
inguvanda kāryatte ellārum śollanum,	everyone should mention the work which has brought us here,
inbamā pōgaṇam.	(and) disperse with love.
puḷḷārappan kōyilakku,	to the pillyyār temple,
puvyśutti vēṭṭyyāḍi,	tied flowers, and (after) hunting,
poṇṇē, vīṭṭy vandēn.	girl, I came home.
annamē, ponnammā, taṇṇi koṇḍā.	my swan, my gold, bring water.
ōḍeyile, viḷyyāḍayile,	while running, while playing,
oru ōṭṭa karaṇḍavamum kaṇḍaḍattēn,	a broken chunam-box I saw, and lifted it up.
kaṇṇu śimiṭṭiyō, kāryam koṇḍāyō,	(with) winking your eyes, (you have) won your object,
kaṭṭaḷagi muttu vīrāyi,	my beautiful pearl Vīrāyi.
śālyyile, viḷyyāḍayile,	while playing on the road,
oru śanga śarappaḷi kaṇḍeḍattēn.	I saw a conch-necklace, and lifted it up,
kaṇṇu śimiṭṭiyō, kāryam koṇḍāyō,	(with) winking the eyes, (you have) won your object,
kaṭṭaḷagi muttu vīrāyi.	my beautiful pearl Vīrāyi.
kākkā śōlam, karam śōlam,	crow-like *jowar*, black *jowar*,
kalandu verekkambōdu, pūkkādellām pūkkudam,	while mixing (and) sowing them, even the flowers that cannot bloom, do bloom,
pūttu maṇakkudām.	blooming, send forth fragrance.
puṇṇiya vāśalile pūttu maṇakkudu,	they bloom before the temple door, radiating fragrance.
ūrku mērke otte vīṭṭile,	In the solitary house to the west of the village,
pālarumy, pālarumy,	a milch-buffalo, a milch-buffalo,
ōṭṭiyāra śolli pārpe ittaram nambadury.	our master has asked us to bring it back.

1 Śiva as Śeṭṭi sold bangles.

2 Kāttavarāyan is said to have married a Brāhmin girl called Āryamāla. Kāttavarāyan himself was a Paryyan.

3 Subrahmaṇya put on an old man's disguise to marry Vaḷḷiammāḷ, the daughter of Viṣṇu.

KANNIGAḶ PĀṬṬUGAḶ—2[1]

Tamil	English
Koṭṭu kūḍy, koṭṭu kuḍy, kuḷḷātti koṭṭu kūḍy,	Small basket, small basket, O, dwarfish girl, small basket,
nāttināmma nāttinā, nākkarinda taḷyttinār,	*nāttinā, nāttinā*,[2] her tongue is cut.
śembu ṭavaly, śellāda kāśu, śembu tavaly śellāda kāśu,	copper pot, bowl, the bad coin,
pū pū puḷiyampū, pū pū puḷiyampū,	flower, flower, tamarind flower, flower, etc.,
ponnāngāṇṇikki tāḷambu, ponnāngāṇṇikki tāḷambū,	*ponnāgāṇṇi* flower, screwpine flower etc.,
ariśi virkum amrida valli, ēlambaḍi ēlālō,	Amridavalli who sells rice, *ēlambaḍi ēlālō*,
onpuruśan enge pōnān, ēlambaḍi ēlālō,	where is your husband gone, *ēlambaḍi ēlālō*,
karungaḍalu ōrattile, ēlambaḍi ēlālō,	on black sea shore, *ēlambaḍi ēlālō*,
kaḍan vāngi tiny vidyttān, ēlambaḍi ēlālō,	he sowed seeds bought with loaded money, *ēlambaḍi ēlālō*,
karunguruvi porakkudenru, ēlambaḍi ēlālō,	thinking that the black sparrow will destroy the seeds,
kāralurku pōnāroḍi, ēlambaḍi ēlālō,	he went there to keep watch, *ēlambaḍi ēlālō*,
śettānenru śēdigēṭṭāl ēlambaḍi ēlālō,	(if I) hear news that he is dead, *ēlambaḍi ēlālō*,
śēly vāngi pōṭṭaluvēn, ēlambaḍi ēlālō,	I will wear a sari and weep, *ēlambaḍi ēlālō*,
māndān enru śēdigēṭṭāl, ēlambaḍi ēlālō,	(if I) hear news that he is dead, *ēlambaḍi ēlālō*,
māly vāngi pōṭṭalavēn, ēlambaḍi ēlālō,	I will wear a garland and weep, *ēlambaḍi ēlālō*,
piranda many śēdi pōnāl, ēlambaḍi ēlālō,	if I go back to the house in which I was born,[3] *ēlambaḍi ēlālō*,
peṭṭi peṭṭiyāi puspavarum, ēlambaḍi ēlālō,	box, box, full of flowers I get, *ēlambaḍi ēlālō*,
nān vālunda many śēdi pōnāl, ēlambaḍi ēlālō,	if I go back to the house in which I grew up, *ēlambaḍi ēlālō*,
vanḍi mīdu variśe varum, ēlambaḍi ēlālō,	on a cart will I get *variśe*[4] *ēlambaḍi ēlālō*,

KANNIGAḶ PĀṬṬUGAḶ—3

Tamil	English
Orāndān tingaḷily, tāyē,	In a certain month, O, mother,
oruvagy puveḍattēn.	I picked up a certain kind of flower,
puveḍattēn, puṭṭiliṭṭēn,	I picked it up (and) put it in a basket,
poyyāmaram śērnda kanni, daiva kanni,	the *Kanni* who joined the *poyyāmaram*[5] is a divine *Kanni*,

[1] The following song describes an unhappy marriage from which the young wife feels the only escape is her husband's death. She hopes for an accident, so that as a widow she may go back home, and remarry, in which case her parents would give her a new dowry.

[2] Nāttinā is the husband's sister, and between a woman and her *nāttinā* hatred is the normal relation.

[3] and [4] It is usual for the widow, unless she is past middle age, and with grown-up children of her own, to go back to her parental house after her husband's death.

[5] A tree that never fails to give flowers.

Tamil	*English*
ēlandaramma nīrāḍe,	get up *Kanni*, for water-sport,
nīrāḍi nīrkuḷıttu, nalla nīlavarana paṭṭuḍuti,	having sported in water, bathed, and wearing a good blue silk sari,
vā vā vā kannimāre, vādāḍi,	come, come, come, *Kanni*, discuss,
śudāḍi pandaḍippōm,	(play at) deception, (and) beat ball,
pandu marukolundu pādayile nirkudaḍi.	the ball, (and) *marukolundu* (leaves) stand at your feet.

KANNIGAḶ PĀṬṬUGAḶ—4(a)

Tamil	*English*
Nalla nalla kanni vāśalile nāli nelly koṭṭi kāya vyttēn kāya vyttēn,	Good, good virgins[1] at the door, I poured out a (*nāli*)[2] of paddy before the door to dry,
nellu śēdambōci kanniyammāḷ vandirukkam vēḷeyāci,	the paddy decreased, (and) it is time for the arrival of *kanniyammāḷ*,
pacce vaḷeyil paḷa paḷanga,	while the green crops are shining, (and)
pattini pengaḷ kytāḷam pōḍa,	wives are clapping their hands (and dancing),
śīna vaḷeyil kala kalanga, iru jōṭṭa pengaḷ kytāḷam pōḍa,	(while) China bangles are making *kala kala* noise, (and while) pairs of girls are clapping hands,
anda teruvile āru kanni, inda teruvile āru kanni,	six[3] girls in that street, (and) six girls in this street,
pannirandum kannigaḷam kūḍikonḍu, kaḷimy vandōm vaḷyyāḍa,	twelve girls together, on a certain day of the month we came to play.
magarājan vāśal tēḍi vandōm vaḷyyāḍa,	we came asearching to the *mahārāja's* door,
śēly gaṭṭuvōm, teruvu naḍandupōm,	we shall tie up saris, (and) we shall walk the street,
śīmānām śinna dury vāśal tēḍi,	the wealthy young king, his door asearching (we came),
māly pōḍuvān, vaḷi naḍattuvān,	(he will) garland us, he will escort us on our way,
magarājan śinna dury vāsaladu.	it's *mahārāja*, young king's door.
padakku, tuni porakki pāḍe mēl pōṭṭukonḍu,	(we) searched for an armful of clothes,[4] (and) secured it, (and) putting it on a bier,
paṭṭanam nāl dikkum vandēn vaḷyyāḍa.	we came to the town to play,
kurani tuni porakki, kūdy mēl pōṭṭugonḍu,	(we) searched for a *kurani*[5] of clothes, (and) put them in a basket,
kūḍa svarna vāśalikku vandēn vaḷyyāḍa,	together we came to the gold door to play.
tōḷile śērupaṭṭāl nāngaḷ tuḍyppōm,	if mire attaches to shoulder, we shall wipe it,
tuttiyappū śeḍiyile, konḍayile nāngaḷ muḍippōm,	in our hair-knot we shall stick *tutti*[6] flowers,

1 Virgin here refers to the *Kannis* whose arrival is expected.

2 A fourth of a measure of paddy.

3 In one particular version I have it as 7, and if the reference is to the deities I think the latter version to be correct. The Seven Village Deities (including Māri & Pidāri) of South India are well known.

4 The word padakku literally means a measure equal to 2 *marekāls* or 2 *kurunis*.

5 A *kuruni* is equal to a *marekāl*.

6 A wild flower, trumpet-like in shape.

Tamil	*English*
mārule śērupaṭṭāl nāngal tuḍyppōm,	if mire has attached itself to the chest, we shall clean it,
māllige pū śoleyile konḍy muḍippōm,	in the jasmine garden, we shall decorate our hair knot (with jasmine),
alli taḷīngaḍiī sandanatte, alagāna namba kanni dēgattile,	take sandal (solution) and sprinkle on the body of our beautiful *Kanni*,[1]
kiḷḷi taḷīngaḍi sandanatte, kiḷi piḷḷy namba kanni dēgattile,	with fingers sprinkle sandal (solution) on parrot-like *Kanni's* body,
śunnāmbu karanḍavamum tuṇi mēl vyttiviṭṭu,	keeping the chunam-box on a cloth,
śollāmale pōgarāḷ, śudagāra nāciyāḷ,	goes away the deceitful woman (*Kanni*),
pākaṭṭi karanḍvamum pāi mēle vytupuṭṭu,	the arecanut-cutter (and) chunam-box, keeping them on the mat,
pākkāmal pōgarāḷ puligāra nāciyāḷ,	goes away without (even) looking (at us), the murderess,[2]
āla śuvaram alari viḷa, āgāsa ammantēr ōḍivara,	as the hall wall collapses suddenly. (and) the sky-mother's chariot comes arunning,
kuṭṭi śavar kudittu viḷa, kuḍakuḍa amman tēr ōḍi vara,	as the dwarf wall collapsed into a heap, (and) the mother's chariot came arunning noisily,
māvy pāru māvu alagu pāru,	look at the flour, look at the beauty of the flour,[3]
māvu mēl vytta aḍi pāru,	look at the imprint (of the mother's feet) on the flour,
pūvy pāru, pūva alagu pāru,	look at the flower, look at the beauty of the flower,
pūvu mēl vytta aḍi pāru,	look at the imprint (of the mother's feet) on the flower,
ēnḍi ēnḍi nāciyār, innēram tāmadam?	why, why, woman, why did you delay so long?
ēl kaḍal tānḍı eḍattu vandēn tāmaram,	I crossed the seven seas (and) brought the lotus,
añdiyaḍi kanni sandiyaḍi, āvāram pū pūkkum vēḷeyaḍi,	it is evening *Kanni*, it is evening, it is the time when the *āvāra* blooms,
ucciyaḍi kanni ūruvumaḍi ūmattān pū pūkkum vēḷeyile,	it is midday *Kanni*, it is midday, it is the time when the *ūmattān* blooms.
pāci mulangara nērattile,	it is the time when the conch is blown,
pallākku vēṇu menbāḷ namma kanni,	our *Kanni* demands a palanquin;
ecci mulangara vēḷeyile,	at the noise of the morning,
elandu vara vēṇumenbāḷ namma kanni	our *Kanni* wakes up (and) comes (to us)
āttile pōra arakan śeṭṭi yāradu?	whose is the bowl that is floating in the river?[4]
adudānḍi namma nācciyār ānḍapanḍam pōvadu,	it is the vessel that our woman (*Kanni*) inherited from her ancestors,[5]

1 This line is spoken by village girls. They are worshipping the *Kannis* with sandal etc., and cleaning the deities' bodies of road dirt. Throughout the *Kanni pāt*, it is very hard to tell who's speaking the lines, whether the deities or the girls.

2 The mood changes and the worshippers have started abusing the *Kanni*, with the epithets, 'deceitful' and 'murderess.' The quick change of mood is not easily explained, and does not enhance the song's clarity.

3 A favourite form of propitiation of any deity is lighting the '*māvaḷak*.'

4 Again the theme of the song changes. This defect characterises all the *pongal* songs; and obscures their meaning greatly.

5 *Ānḍampanḍam* is the term used for the vessels which descend to a woman from her ancestors.

Tamil	*English*
kuḷattile pōra kuṇḍan śeṭṭi yāradu?	whose is the round pot that floats in the pond?
adudāṇḍi namma naccyār āṇḍa paṇḍam pōvudu,	it is the pot that our woman (*Kanni*), inherited from her ancestors.
nāṇal peridenru nāṇal mēl erunēn,	as the *nāṇal*[1] grass was big, I got upon it,
nāṇal tovaḷudaḍi kydāḍi nāccyār.	the *nāṇal* shakes, O, woman (*Kanni*), extend your (supporting) hand,
pūlā perḷdenru pūlā mēl ērinēn,	as the *pūlā* (plant) was big, I got upon it,
pūlā tovaḷudaḍi kydāḍi nāccyār.	the *pūlā* shakes, O, woman (*Kanni*) extend your (supporting) hand,
pattu paṇam pōṭṭu śēly eḍattu vandēn	spending ten *paṇams*[2] I bought a sari,
nānaḍattu kaṭṭāmal nangy kaṭṭi pārpāḷām.	the deity (*nangy*) will see how it looks on her before I try it on myself,
nangytaḷy mēle nallōle varuvudām,	on the deity's head will come good news,
nallōle vāśikkum veḷḷāḷam vārānām.	to read the good news the *Veḷḷāḷa*[3] will come,
veḷḷāḷan taly mēle verekōṭe varuvudām.	on the *Vellala's* head comes the seed-fort,[4]
verekōṭe kutti vaḍikka veḷḷāṭi vārāḷām.	the *Veḷḷāṭi* (woman) will come to pour (and)cook the rice in seedfort,
veḷḷāṭi taly mēle iruppulakky varuvudām,	on the *Veḷḷāṭi's* head will come the iron pounder,
iruppulakky irutti pōḍa innorutti vārālām.	to lift the iron pounder another (woman) will come.[5]
va*l*imuḷḷenru vārāde pōvāde,	don't go away without coming (to us) as there are thorns on the road,[6]
va*l*i muḷḷu eḍakkarēn vandu pō nāciyār,	I will remove the road-thorns, come O, woman,
teruvḷḷe muḷḷennu tirumbāde pōvāde,	don't go away without coming to the street as there are thorns,
terumuḷḷa eḍakkarēn tirumbipoḍi nāciyār,	I will remove the street-thorns, come O, woman.
tacca kaṇṇē, taly vā*l*y kaṇṇē, un tambi iruvar ponār,	O, carpenter's boy,[7] dear plantain shoot, two of your (younger) brothers went,
kolly kaṇṇē, koly vā*l*y kaṇṇē, koṭṭi iruvarum engo pōnār?	darling of the backyard, plantain darling of the backyard, where are the two carpenter boys gone?[8]
pākku perundadu parangipēṭe rājyam,	in Parangipēṭe kingdom there was a bumper crop of arecanuts,

[1] A tall variety of grass growing on river banks, and in damp, marshy places. The theme has changed again !

[2] One *paṇam* is roughly equal to two and a half annas—ancient coin common to all parts of South India.

[3] Agriculturist Caste.

[4] *Verekōṭe* is a small "fort" to preserve paddy for lean days and for seed. The straw-case is leeped with cowdung and secured with straw rope.

[5] Usually pounding is done by two women, one who does the pounding, and the other who pushes the paddy into the mortar. The position frequently interchanges to relieve strain.

[6] These lines are addressed to the *Kanni*. Common to all *pongal* songs.

[7] Note change of theme. The term actually used means 'my eye.'

[8] Probably, a mourning relative asks the plaintain tree in the backyard, 'where are the boys gone ?'

Tamil	*English*
pakku vele madikka pōna eḍattil,	the spot where (they) went to estimate the price of the arecanut (crop),
puttu irandānām tacca pyyan.	the carpenter boys died there.
śīppu perundadu śirgāyi rājyam,	in Śīrgāyi kingdom there were plenty of combs,
śīppu vele madikka pōna eḍattil,	the spot where (they) went to estimate the price of combs,
śattu maḍindānām tacca pyyam,	the carpenter boys died there.
enga nāciyār vārāḷe, ponga nāciyār vārāḷe,	our woman is coming, gold woman is coming,
engaḷellā paṇṇi pōṭṭa ponga perumāḷ vārāle,	the gold deity who made us all is coming,
pōraḍi nelle pori porikka vārāḷe,	the paddy found in heaps of straw, she comes to parch the paddy,
tāḷāḍi nelle taviḍaḍikka vārāḷe,	she comes to pound the bran of the second crop of paddy.
nāya kutti narambeḍattu nalla pīḍarikku kaṇṇu terandu,	spear the dog, remove its nerves, (and) open the eyes of the good pīḍāri,[1]
punyyai kutti puḷuveḍuttu pīḍārikku kaṇṇu terendu,	spare the cat, remove the worm, (and) open the eyes of the gold pīḍāri,
indu veraḷukkum ivira lakṣaṇam,	five qualities (*lakṣaṇa*) for the five fingers,
pattu veraḷukkum paśumbōn mōdiram.	for the ten fingers, rings of the best quality gold.

KANNIGAḶ PĀṬṬUGAḶ : 4(b)

The following *Kanni* song describes the conflict between a mother-in-law and a daughter-in-law, which culminates in the latter's death. The latter has an *aṇṇan*, who is like Bhīma, and who, enraged, puts the mother-in-law to disgrace by making her ride, naked and with her head shaved, a donkey round the village, and in the end, hurls her into a burning lime-kiln. He cuts down the other seven daughters-in-law who abetted in the 'murder.' The tale is gruesome, but it helps to focus our attention on two important points : 1, the inevitability of the mother-in-law—daughter-in-law conflict in a society based on the joint family; and 2, the attachment between *aṇṇan* and *tangy*. The terms in which the *aṇṇan's* affection for the *tangy* is described and the revenge he takes, suggest to one, though *very remotely*, the conflict between a superseded matrilineal organisation, and a superseding patrilineal organisation. The *aṇṇan* of the girl symbolises the former, and the mother-in-law, the latter. The revenge which destroys the latter is a nostalgic wish for a past golden age which did not contain the evil of the mother-in-law.

In the song, some confusion arises out of all the daughters-in-law being described as the '*aṇṇan's* daughters.' The song can only be followed if we assume 7 daughters-in-law, and another who had an *aṇṇan*...

[1] The villagers have made an image of Pīḍāri, and the eyes have to be drawn on it. But what does the reference to spearing the dog and cat mean ? Were they offered to the Pīḍāri ? Nowhere in printed literature do we hear of such an offering.

Tamil	*English*
1. Attyyārē, śittāḍekaṭṭi mōruvirka pōrēnattē,	1. O, *atty*,[1] after tying my sari, I will go to sell buttermilk,
unbāre pārtālum uluvāre pārkalāma ?	even if one sees a diner, may one see a plougher?[2]
tinbāre pārtālum tirumbi pāraklāma ?	even if one sees an eater, may one take another look at him ?
ēlu marumagaḷukku ennivittāḷ mōrgaḷellā,	to the seven daughters-in-law[3] she measured out buttermilk (to sell) ;
annan pettra ratigaḷukku aḷanda mōr koḍutāḷ ange,	to the elder brother's daughters,[4] there she measured out buttermilk,
ēlu marumagaḷam ēlu paṭṭanangaḷ śutti varargal,	the seven daughters-in-law go round seven towns ;
annan pettra arangiḷiyam annanviḍu tēḍipōnāl,	the beautiful parrot that the elder brother begot, she goes to the elder brother's house ;
ēnammā, en tangyyāre ivaḷo duram vandāi?	why, my *tangy*, why, did you come such a long way ?
mōru virka vandēn, annā, mōśam vandu nikkarēnannā.	I have come to sell buttermilk *annan* I have fallen upon evil times ;
ēlu nalla marumagaḷam ēlu kalam nelly vittu vārārgaḷ,	the seven good daughters-in-law sell seven *kalams* of paddy ;
annan petta arungiḷikku nalla nelly tān kuḍuttāḷ,	to the parrot-like daughter of *anna* she (mother-in-law) gave good paddy,
ēlu marumagaḷam ēlu kalam nelly vittu vandār,	(the) seven daughters-in-law sold seven *kalams* of paddy,
annan peṭra arungiḷi orē nelly viṭra vandāḷ,	(the) beautiful parrot-like daughter of elder brother sold only one grain of paddy,
yāruḍeya bōdaneyō orē nelly viṭru vandāḷ,	she sold only one grain, (god knows) on whose advice,[5]
paśiyāi irku atty, tanni irundāl tārum atty,	I am hungry, *atty* (she said), if you have water, give me (to wash my face and feet with),[6]
ēlu nalla māṭṭu koṭṭa ēlu nālikuḷḷe vāravēnum,	the seven good cowsheds in seven *nālis*[7] should you clean,
ēlu māṭṭu śāni yellā ēlu nāḷi kuḷḷe taṭṭa vēnum,	the seven heaps of cowdung in seven *nālis* should you make (fuel) cakes with,
śāni yellā taṭṭi pōtēn, tanni irundāl tārum atty,	I have made the fuel cakes, if you have water, give me.
ēlu kaḷa nellellām oru nāli kuḷḷe kutta vēnḍum,	seven *kalams* of paddy you should pound within a *nāḷi*,
nellella kutti viṭṭēn tanni irundāl tārum atty,	I have pounded the paddy, if you have water, give me.
kalam umi yellā oru nāli kuḷḷe śaḷikka vēnḍum,	seven *kalams* of husk you should winnow within a *nāli*,

1 *Atty* is mother-in-law as well as father's sister. In this story, however, she is the mother-in-law.

2 A proverb which enjoins one to vie with another in work.

3 Marumagaḷ is daughter-in-law as well as brother's daughter (W.S.) and sister's daughter (M.S.).

4 There is an element of confusion introduced in this word. All the daughters-in-law are called elder brother's daughters. The story can only be followed properly if we assume seven daughters-in-law and another who has an elder brother.

5 The daughter-in-law is also on the war path. Probably, what is suggested here is that she retaliated on her brother's advice.

6 Procedure before dining.

7 One *nāḷi* is equal to 24 minutes.

Tamil	*English*
umi yellā śaliṭṭuviṭṭēn, tanni irundāl tārum atty,	I have winnowed the husk within a *nāli*, if you have water, give me.
kattari śeḍingaḷakku kanattannīr utta vēnḍum,	the *brinjal* plants, water them with well-water,
kattari śeḍingaḷakku kanaṭṭannīr ūtti viṭṭēn,	I have watered the brinjal plants with well-water,
kaly yāyi varudattē, tanni irundāl tārum atty,	I am tired, *atty*, if you have water, give me,
nārattān śeḍingaḷakku naḍandu tannīr ūtta vēnḍum,	the *nārattām*[1] plants have to be watered, awalking,
naḍandu tannīir ūtti viṭṭēn, tanni irundāl tārum atty,	awalking I have watered the plants, if you have water, give me,
muḷaga śeḍīngaḷakku monḍu tannīr ūtta vēnḍum,	the chilli plants have to be watered by bailing out water,
monḍu tanni ūtti viṭṭēn, tanni irundāl tārum atty,	I have (watered the chilli plants by) bailing out water, if you have water, give me,
kādu aḍakkudatte tanni irundāl tārum atty,	I am deaf with hunger, if you have water, give me.
vā*l*y nalla marangaḷakku vāri tannīr orakka vēnḍum,	you should water the good plantain trees by throwing water (to them),
vāri tannīr ūtti viṭṭēn, tanni irunḍāl tārum atty,	I have watered them by throwing water (to them), if you have water, give me.
tenny yāi kanāngu tēyki tannīr erakka vēnḍum,	The cocoanut trees should be watered by banking up water (and) hurling water on them,
tēngi tannīr eratti viṭṭēn, tanni irandāl tārum atty,	I have hurled water (on them), if you have water, give me.
ē*l*u nalla toṭṭiyellā eḍattu tannīr ūtta vēnḍum,	the seven tubs should be filled with water,
eḍattu tannīr utti viṭṭēn tanni irundāl tārum atty,	I have filled them with water, if you have water, give me.
ē*l*u maṭra vāśalellā oru nāḷi kuḷḷe kutta vēnḍum	the seven courtyards should be swept in a *nāli*,
oru nā*l*i kuḷḷe kutti viṭṭēn tanni irundāl tārum atty,	in a *nāli* have I swept them, if you have water, give me.
ē*l*u viṭṭu arygaḷellām oru nimiśatti-kuḷ mo*l*agavēnḍum	the rooms in seven houses should be cleaned (with cowdung) in a minute,
oru nimiśattil molugiviṭṭēn, tanni irundāl tārum atty	in a minute have I cleaned them, if you have water, give me.
kuḍumbattu puḍavy yellām konḍu pōyi kaśakka vēnḍum,	The saris in the house should be washed,
tuni kaśakki vīḍu vandēn, tanni irundāl tārum atty,	I have washed the clothes, if you have water, give me.
vennīr nalla śuda vyttu, enneyum ekulapāṭṭa-vēnḍum,	heat the water well, (and) give me a bath,
ellā vēly śeyadu viṭṭēn tanni irundāl tārum atty,	all the work I have done, if you have water, give me.
pāḷadynda kēlvaragy pārtu aḷḷi tān koḍuttāḷ,	old *ragi* (*atty*) deliberately gave for grinding,
vidiyaḍynda entiratil vēgamā areki śonnāḷ,	she ordered it to be ground quickly in the broken machine,
paḷḷamuḷḷa entirattil pārtirunda nāga-monru,	in the uneven machine was a cobra,
kakki vytta viśangaḷellām kalandady māvinā mēlē,	the poison which it spouted mixed with the flour,

[1] Seville, or bitter oranges.

Tamil	*English*
āvaluḍan aḷḷi uṇdāl āraṉang mādu tānum,	the divine girl ate that flour with desire,[1]
paṟalōkam śēndu viṭṭāḷ pattinuyum peṇmaṇiyē,	she went to heaven, the wife, the jewel among women,
śēdi arindāne svantamuḷḷa aṇṇanum,	her own brother heard the news,
aṇṇan vandu tān a*l*udān arume peṇ vāśalilē,	the *annan* wept at the door of his beloved sister,
attyyāre śittāḍatti arume peṇṇum tānu enge,	*atty*, where is my beloved girl? (he asked),
ēḷu pēru irkum pōdu en eḷam koyinde enga tān,	while here are the seven others, where is my tender baby?
mōru virka pōnaḍattil tirumbi varally yaḍā.	she did not return from the place where she had been for selling buttermilk.
yāruḍan pēśināḷō inguvandu śēravilly,	(god knows) with whom she is speaking, she has not yet reached this place,
nelly koḍuttanappi nēru va*l*i kāṭṭi-viṭṭēn,	I sent her with paddy, I sent her on a straight path,
va*l*i śalave nānguḍuttu mangeyare anappi vittēn,	I sent all the girls giving them money for the expenses of the road,
eṇṇi ninyttānavan eṇṇe paṭṭa pondiyale,	(the brother) thought many things in his brain,
uṭṭru ninyṭṭānavan oru kōṭi yōcany yāi,	he thought a crore of thoughts,
tangy uyiru pōnadināl, tān uyiry vānga vandēn,	he had come there to take a life in exchange, for his *tangy's*,
mangy uyiru pōnadināl, maru uyiry vānga vandēn,	because of the loss of a girl's life, he had come to take another life.
muṭṭe aḍigtu avan mundu rāmam śāttinānē,	he shaved (the *atty's* head)[2] and decorated her forehead with three *nāmas*,[3]
karumbuḷḷi kuttiyavan ka*l*idemēl ēṭrinānē,	(her nude body) he marked with black dots, (and) he got her upon a donkey,
eringenra śuly yilē ēndiyāi kuḷatti-viṭṭu,	he burnt the woman (throwing her) into a burning lime-kiln,
tangy, marumagaḷam tayyalēḷu pērgaleyum,	the seven daughters-in-law,
veṭṭi uyır maḍittān vīma nāna aṇṇanavan,	he hacked them all, the Bhīma-like *annan*,
vīṭṭy ku*l*atti viṭṭān verum śāmbal ākki viṭṭān,	he burnt (the mother-in-law's) house to a heap of ashes,
śonda uru tān pōyi sogasuḍany vā*l*du vandān.	(then) he went into his own town and lived happily.

KANNIGAḶ PĀṬṬUGAḶ—4(c)

A number of women stand in a circle facing each other, and they sing the following song ten times, to the accompaniment of clapping of hands. One person's palms hit the palms of the person standing opposite to her. This mode is called the '*kummi taṭṭara pāṭ*,' and the particular beat adopted here is the '*āvāram koṭṭu*.'

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[1] It is a moot point whether she ate the flour because she was very hungry, or knowing that the only way out of her misery was death, she deliberately committed suicide.

[2] The punishment which the song describes was one common in the days of yore, for anyone who committed a serious offence (like adultery with a member of a lower caste).

[3] *Nāmāms* are worn on the forehead by the Śrīvaiṣṇava Brāhmins, and other Vaiṣṇavas.

Tamil	*English*
Oru kuḍame tūkkinēn,	I lifted up a pot,
orāyiram pāvakkāi,	one thousand bitter gourds,
orāyiram pāvakki,	one thousand bitter gourds,
śeṭṭilingam pāvakkāi,	*śeṭṭilingam* bitter gourds,[1]
śārkācum pāvakkāi,	bitter gourd with which soup is made
ākkalāmō, arikkalāmō,	may we prepare (soup), may we take what is prepared (in the vessel),
ayyātingara pāvakkāi.	the bitter gourds which *ayya*[2] eat.

KANNIGAḶ PĀṬṬUGAḶ—4(d)

Though the song appears to dawdle along without caring for sense or rhyme, really, it is very pathetic, and gives us a graphic picture of the widow. Here she is seen accusing her caste-women of removing her *tāli*, and thus burning away her beauty. She is on the streets, with no food to eat. She compares herself to the Tamil Queen Alli who secured a *vimāna* to carry her dead husband's body to *swarga*.

Tamil	*English*
Kattiyāle, kattiyāle, vāgaḍuttu, ē ammamārē, ē āccimārē,	With a knife, with a knife, parted the hair, ē *ammamare*, ē *āccimare*,[1]
kaccidammā, kaccidammā, poṭṭumiṭṭu,	with beauty, with beauty, put the *śānd* mark,
kattinallō, kattinallō, muny vuḍinda,	good knife, good knife, if its point broken,
kaccidammā, kaccidammā, poṭṭu alandēn,	with beauty, with beauty, the mark is rubbed out,[2]
tennōlettān, tennōlettān, kondallavē, ē ammamārē, ē āccimārē,	coco palm leaf, coco palm leaf,[3] is it not with it, ... *ē*, etc.,
teruvu perakka yilē, ē,	that the street is swept,
tennōlekkō, tennolekkō śādamilly, ē ē ammamāre, ē āccimārē,	to the coco palm leaf, to the coco palm leaf, there is no rice, . . . *ē*, etc.,
teruvukkōdān, teruvukkōdān, śentamilly.	I have no right over the streets, I have no right over the streets, it is not mine,
vāḷalyttān, vālalyttān, kondeyālē, ē mārē, ē āccimārē,	(with the) plantain leaf, plantain leaf, ... *ē*, etc.,
vāśalyyam, vāśalyyam, perukkayilē,	the doorfront, the doorfront, while sweeping,
vāḷalykkum, vāḷalykkum, śādamilly ē ammamārē, ē āccimārē,	there's no food for the plantain leaf, for the plantain leaf, ... *ē*, etc.,
vāśalukkum, vāśalukkum, śentamilly,	the doorfront, the doorfront, it's not mine,

[1] *Seṭṭilingam* is an epithet usually used along with *pāvākkāi* or bitter gourd.

[2] *Ayya* is a term used by menials towards their masters, and by the non-Brāhmins towards the Brāhmins. Ayyar and Ayyangār are obviously derived from it.

[1] *Ācci* is the term used for Veḷḷāḷa women, in Cheṭṭināḍ. *Amma* is a synonym.

[2] She tries to put the mark with a knife point.

[3] Probably, it is a figurative way of saying that the woman has no food to eat. The palm leaf mat is used, like the plaintain leaf, as a dining plate. She has no food, so she uses both the leaves to sweep streets and doorfronts which don't belong to her.

Tamil	*English*
ara kāśi, ara kāśi, nūlu kundu ē ammamārē, ē āccimārē,	one pie, one pie, a ball of thread,[1] .... ē, etc.,
arappavanu arappavanu, tālikundu,	half a sovereign, half a sovereign, *tāli* beads,[2]
ennaḷagy, kuḷetirgaḷō, kuletirgaḷō,	my beauty, (you) burnt, (you) burnt,
avattu vykka śonnirgaḷō,	(you told me) to untie (the *tāli*), you told me,
oru kāśi, oru kāśi, nūlukundu, ē ammamārē, ē āccimārē,	one pie, one pie, ball of thread, ... ē, etc.
en uruvy kulytirgaḷō, kulytirgaḷō, ē ammamārē, ē āccimārē,	my beauty, (you) burnt, (you) burnt,
uruvivykka śonnirgaḷē, śonnirgaḷē,	to take the *tāli* (from the thread), you told, you told,
parakkaradān, parakkaradān, kappal varum, ē āccimārē, ē ammamārē,	flying, flying, ship will come, ... ē, etc.
pattu maṇi, pattu maṇi, puṭṭivarum,	ten bells, ten bells, the basket will come,
pattiniya vāitarandāl, vāitarandāl, ē ammamārē, ē āccimārē,	if the chaste woman opens her mouth (in speech), opens her mouth, ... ē, etc.,
pattu nāḷām, pattu nāḷām vaṭṭa miḍum,	(for) ten days, (for) ten days, it will be hovering round in a circle,
āgādān kappal varum, kappal varum, ē ammamārē, ē āccimārē,	the sky ship (aeroplane, *vimāna*) will come, the ship will come, ... ē, etc.,
alligy śītku, śīṭṭu varum, ē ammamārē, ē āccimārē,	Alligy's letter,[3] the letter will come, ē etc.,
alliyāl vāitarandāl, vāitarandāl, ē ammamārē, ē āccimārē,	if Alli opens her mouth, opens her mouth, ... ē, etc.,
indunāḷ vaṭṭa miḍum, vaṭṭa miḍum.	for five days it will be hovering in a circle.

(To be continued)

[1] The price of the *tāli* thread, yellowed with turmeric, is said to be a pie.

[2] Flanking the *tāli* are gold and coral beads. The gold beads and *tāli* were made of half a sovereign of gold.

[3] Alli, a Tamil Queen, a Virago, who was exceedingly domineering. Tradition has it that she commandeered a *vimāna* to carry away her dead husband's body. The *vimāna* was hovering around for five days waiting for the corpse. The mourner compares herself to Alli. Probably she has no money to meet the funeral expenses.

BOOK REVIEWS

Isma'ili Tradition concerning the Rise of the Fatimids. By W. Ivanow. Published for the Islamic Research Association, Bombay, by Humphrey Milford, Oxford University Press, Bombay, 1942.

IN the field of Isma'ili research, Mr. W. Ivanow's services are too well-known to require special mention. His latest publication—*the Rise of the Fatimids* is one more addition to his numerous works on Isma'ilism. Through the efforts of pioneers like Mr. Ivanow, the history and literature of the Isma'ilis of different schools was made accessible to modern scholarship for the first time. Unlike his predecessors, he availed himself of the original sources of the Isma'ilis and based his researches on their hitherto unknown works, an account of which is contained in his somewhat sketchy, but useful work—*A Guide to Isma'ili Literature* (London, 1933). The present work is an attempt to study from the original Isma'ili sources one of the aspects of the history of the Isma'ilis, *viz.*, the establishment of the Fatimid Caliphate in North Africa by al-Mahdi in the A. H. 3rd./A.D. 9th century—a momentous event which had far-reaching repercussions on the trend of events not only in the Islamic World, but "even affected," in the words of Mr. Ivanow, "the history of the far away Christian Europe, as in the case of the Crusades." In the light of this Isma'ili literature, unearthed, as the claim goes, during the last two decades, Mr. Ivanow deals with the history of the advent of al-Mahdi in A. H 297/A.D. 909 and discusses, in a style, which is pungent, though stimulating, such questions as the 'Alid descent of the Fatimids and the myth o- 'Abdullah b. Maymun al-Qaddāh, the Jew—questions which have always confounded historians.

Since the material at the disposal of Mr. Ivanow is more theologicalf than literary, more hagiological than historical, certain difficulties are bound to arise for the learned author in the course of his investigation, but these have been to a large extent admirably surmounted by the application of the critical standards of historical research, particularly in respect of numerous texts of which the author has availed himself. The learned author has made it clear in the introductory part of his book that he wanted to present a complete picture of the subject as it appears in the Isma'īli tradition, hence he has brought in, in his discussions, works of confessedly non-historical character, such as *Zahr al-Ma'ani*, *Asrar an-Nutaqa*, etc., which, according to our opinion, might have been omitted in dealing with purely historical matter. He would have served the cause of learning better had he confined himself to historical works and tried to reconstruct the history of the early Fatimid Empire from both the Isma'ili and non-Isma'ili sources, the latter of which he has not touched at all.

Mr. Ivanow's thesis that Isma'ilism "was probably the most ruthlessly consistent development of the earliest principles of Islam" remains to be examined by other scholars and historians. His thesis may be true, but the same can be also said of many creeds in Islam, such as Mu'tazilism Shī'ism, Sufism. To prove his thesis, Mr. Ivanow discredits Shī'ism

as having taken "the form of absurd and fantastic sectarian beliefs," and tries to establish the superiority of Isma'ilism over Shī'ism, going so far as to say that "Isma'ilism anticipated many advanced phases in the evolution of general Islamic thought." It would have been, however, better if the learned author had substantiated his statement by giving concrete instances and by tracing the parallel developments of these two movements. Remarkable for its all-absorbing eclecticism, Isma'ilism has, in our opinion, borrowed more from sister movements than given to them. As a matter of fact we know from the Isma'ili sources that the Isma'ilis of different schools invented ideological considerations from time to time to suit the changing circumstances in which they found themselves. The conception of *Imamat*, on which the whole structure of Isma'ili theology is based, is purely a shī'ite doctrine, to which Isma'ilis added the principles of *natiq*, *mustaqarr*, *mustawda*, etc., after the "rupture" was complete.

Mr. Ivanow inserts quotations freely, never mentioning their sources. This "irritating method" of which he himself is guilty, he attributes perhaps a little too vehemently to the Yemenite author—Dā'ī Idrīs 'Imād ad-dīn, whom he never fails to run down. It seems that the learned author has read Idrīs 'Imād ad-dīn's '*Uyūn al-Akhbar* only in parts, otherwise he would have qualified his criticism of '*Uyun* and its author. Dā'ī Idrīs has given valuable information about certain aspects of the history of the Isma'ili Da'wat, although we agree with Mr. Ivanow that his meagre account of the early Fatimids is "disappointing." This condemnation of Idris and his works, the slighting manner in which he speaks of the great Queen Arwā the Sulayhid, "Our Noble Lady," his unfair and unwarranted attack on the authors of the Old School of Isma'ilis do, in our opinion, mar the scientific character of his otherwise admirably written and well-documented compilation.

Acknowledging our debt of gratitude to the veteran scholar for his investigations into the Isma'ili subjects, we would have failed in our duty, if we did not bring to his notice, in this short review, the few things which struck us in the course of reading his book. Mr. Ivanow has rendered no mean service to Islamic scholarship in general and Isma'ili studies in particular by publishing the present work. *The Rise of the Fatimids* is a further contribution to our knowledge of the somewhat obscure history of al-Mahdī, the Founder of the Fatimid Dynasty in North Africa and of his predecessors and does supplement, in many ways, Dr. Bernard Lewis' excellent book—*The Origins of Isma'ilism*.

H. F. AL-HAMDANI

Pamphlets on Current Topics. By Padma Publications. Price As. 8.

UNDER the general editorship of Mr. Yusuf Meherally, nice attractive looking booklets at an amazingly low price of annas eight each have been issued by Messrs. Padma Publications. Their idea is to publish every few weeks a pamphlet on a subject of topical or special interest written by a noted authority in each subject. Pamphlets Nos. 1 and 7 deal with China and Japan respectively and are written by Mrs. Kamaladevi Chatopadhyaya. She has been able to pack in them lot of interesting information drawn largely from her recent tour of these

countries. Pamphlets Nos. 5 and 6 deal with Russia and are compiled from extracts out of Louis Fischer's autobiography—*Men and Politics*. The picture of Russia presented here is rather one-sided. Pamphlet No. 2 contains interesting sketches of some Indian political leaders from the pen of Mr. Yusuf Meherally. They are all written in a charming style and abound in anecdotes. Pamphlet No. 4 on the Mystery of Sir Stafford Cripps is a highly original contribution to the understanding of the Cripps Proposals. It has, however, the defects as well as the merits of a brilliant essay.

N. S. PARDASANI

The Land and its Problems. By Sir T. Viajyaraghavacharya. Oxford Pamphlets on Indian Affairs. Price As. 4.

IN a short but comprehensive sketch the pamphlet attempts to give the essential features of Indian agriculture. Beginning with the Indian climates and the classifications of the soils it deals with soil fertility and its erosions, the systems of manuring and the development of irrigation, the varieties of crops raised, famines, animal husbandry and dairying. It also mentions in passing the increasing sub-division of land and the fragmentation of holdings, factors which reduce the economic returns from land, as also the scientific researches made by Government to improve the produce from land. Population is increasing and is pressing on land and the writer sees the need for the reclamation of the "cultivable waste" by enterprising Indian capitalists, with necessary state aid, as these measures are out of the reach of an ordinary Indian cultivator.

He ends his thesis with the conclusion that "what Indian agriculture needs is more brains to be put into land and more state money to be put into agricultural improvement and research," mentioning that the Governments in India spend about 15 pies per head of the population which obviously admits of large and progressive increase.

The pamphlet, useful and informative as it is, omits to mention three important aspects of Indian agriculture which should be studied along with the land problems. The first is the nature of holdings of land. In an eminently agricultural country nearly 65 per cent. of the land is held by non-cultivating holders ; this means that a bulk of the land is cultivated by tenant cultivators paying heavy rents or sharing the produce with the landlord and in several cases rendering all sorts of feudal services. The second factor is the increasing ruralisation of the country throwing more and more men on land which combined with the uneconomic system of inheritance leads to a subdivision of holdings at every inheritance. On one side the number of small cultivators is increasing while nearly five-sevenths of the land is held by about one-third of landholders. Thus, the bulk of the cultivators has to be content with under-subsistence levels, low vitality and illiteracy which keep them outside the influence of modern scientific researches. For these classes, agriculture is a way of life and their economy is modified by many social and religious practices which impede their development. All attempts to help them through the co-operative movement have practically failed.

Unfortunately, these factors have not received the proper attention at the hands of Governments. The function of the Central and Provincial Governments are limited—confined to technical improvements in agriculture, but the larger and more urgent measures of land and social reforms seem to be outside their sphere. Tenancy legislations and rent controls are palliatives and will never solve the main problem of the land which should be owned and cultivated by the owner in the interests of greater efficiency. Social reforms among people, with a hierarchy of castes, each with distinctive economic characteristics and cultural traits, should be attended to by Governments as in other parts of the world. These cannot be solved by the slow process of the present inefficient and purposeless system of eduction which at the present rate would take decades to spread among classes which need it the most.

Unfortunately in our zeal for industrial development, which is certainly commendable, we are neglecting the most essential of our national problem—that of land. The sooner we take up this problem seriously, the better for the uniform prosperity of the whole country.

The book under review, to conclude, outlines the salient facts of our agriculture lucidly. As such the work will be most welcome to the general reader and the practical reformer in need of a handy outline. The purpose of the above remarks is simply to show that we want more of such studies and also more practical effort on the part of the Government and the public.

MANILAL B. NANAVATI

Industrialization. By P. S. Lokanathan. Oxford Pamphlets on Indian Affairs : No. 10. Price As. 4.

THE earlier pamphlets have already been reviewed in these pages and this last fully (or perhaps more than fully) justifies the expectations raised therefrom. Dr. Lokanathan succinctly surveys the three main aspects of the problem—its past records and the lessons derived from these; the impact of war and the achievements in the direction of making India "the arsenal of democracy" and the issues that must needs be faced in the future. The first part, in addition to showing India's "arrested economic development," also emphasises the causes of "such ill-balanced and meagre development" until 1914, such as the lack of indigenous capital industrial leadership and technical skill, serious shortages in the supply of sulphur, zinc, copper, lead, rubber. Looking back on the achievements of the next period 1914—1939, he refers not only to the critiques of para 97 of the Fiscal Commission Report but also to the lop-sided development of industries concerned mainly with the consumers' goods as a result of which industrialization was "coming to a halt unless it was rooted in the prosperity of the agricultural population" (p. 11). Dealing with the second part of his theme, he shows that while there have been some gains in the field of textiles, paper and glass, the establishment of heavy chemical industry and miscellaneous industries, the legacy of the aforesaid handicaps, the want of faith in the policy of the Government, the lack of any future plan, the absence of a trained personnel, still create grave misgivings as to the future. The writer points out that a new situation has arisen as a result of the United States'

entry into the War in 1941, and that much will, therefore, depend on a more intensive, sustained, broad-visioned policy of the Government to-day and upon the industrial and fiscal policy after the War. The assurance given to a few war-industries for fiscal protection after the war, the establishment of a permanent Board of Scientific and Industrial Research and a Research Utilization Committee are steps in the right direction, but, it is pertinently emphasised, the future of India's industry will depend upon external factors too. He pleads that India should not be allowed to be entirely at the mercy of hostile forces working from without, and surveys the problems of power resources, the development of transport the finance of industrialization, location of industries, the co-ordination of small-scale with large scale industries, and the role of the State in all this advancement. The treatment of these topics must obviously be in outline, but the author is able to score a number of points which those concerned with policy would do well to bear in mind. Dealing with capital, he proposes a National Investment Board to arrange for the import, control and allocation of foreign capital. For the long term needs of industries he deprecates the inordinate dependence upon the Managing Agents and advocates the encouragement of Investment Trusts, so that this finance may ultimately rest on national savings. Again these problems are to be viewed "against the background of nationalization of industries" and the economic control of the State must make for a new economy, *viz.*, "the managerial economy."

The student would lay down the pamphlet as a concise, clear and exhilarating summary of the whole problem, the layman as an informative and reliable guide, while the statesman, in addition to these 'reactions,' will find in these 32 pages not a few things that will demand careful attention.

M. C. MUNSHI

Price Control and Food Supply—With Special Reference to Bombay City. By C. N. Vakil, J. J. Anjaria and D. T. Lakdawala, University School of Economics and Sociology, Bombay. Published by N. M. Tripathi & Co. Price Rs. 3.

THE present war has led to the institution of a number of economic controls of which price control has naturally attracted the widest public attention. This is particularly so in India where the rise of prices has been glaring and persistent and where the measures devised by the authorities have, so far, proved to be entirely ineffective.

The publication under review is the first comprehensive and critical survey of the problems of Price Control and Food Supply in this country and provides detailed and accurate information regarding the evolution and working of Controls—Central and Provincial—with special reference to Bombay City. The study is based on an investigation carried out with the assistance of a number of Post-graduate students of the University School of Economics and Sociology, Bombay. The authors deserve to be congratulated on their ability to present a valuable mass of information, in a clear and systematic manner.

The book is divided into ten chapters of which five (Chapters V to IX) are devoted to the special problems of Bombay. The basic economic

issues involved in the institution of price control are ably dealt with in the *First* chapter which starts with the consideration of the fundamental problem of war economy and examines the factors that necessitate the introduction of control. The inherent difficulties of the mechanism of control are then explained and the additional difficulties encountered in India are briefly mentioned. The relationship between price control and monetary policy is indicated in the paragraph which concludes thus: "Price Control without monetary stability—relative, no doubt,—is, at best, a farce ; at worst a cruel fraud on the public, who may not easily discover the root cause of the trouble" (p. 7). The *Second* chapter traces the evolution of price control measures and constitutes an illuminating commentary on the "piecemeal and temporising manner" in which the authorities dealt with the situation from its initial stages. The *Third* chapter describes the development and organisation of central controls on Wheat and Sugar. The recent decontrol of wheat deserves no comment, in the opinion of the authors. The attitude of the authors which is throughout one of cautious criticism verges on the buoyant when they are rather impressed by the comparative success of the sugar control. It appears to be due more to the comparative ease with which sugar is obtainable in Bombay than to real satisfaction at the working of the system as a whole. The *Fourth* chapter deals with the difficulties of transport and exposes the failure of the railways to improve or even to maintain their pre-war efficiency. It is in the *next five chapters* that the investigation carried out through the students has provided the authors with a lot of interesting facts regarding the administrative arrangements made so far for the enforcement of price control measures in Bombay. Having secured their information from various sources, governmental, public and private, the authors have been able to give a connected and objective account of the actual working of price control.

The *last* chapter deplores the failure of Government measures and discusses the charge that hoarding by consumers has been mainly responsible for this. While granting it a limited recognition, the authors are anxious to emphasise that hoarding is more a result than a cause of rising prices ; that hoarding has itself been inspired by lack of confidence in the efficiency of Government to enforce its policy and by the persistence of the inflationary trend in our currency policy. The authors conclude : "The only possible explanation of the present muddle is the way in which the Central as well as Provincial Governments have gone about their work." This is, indeed, a disturbing conclusion and should serve as a timely warning to those in charge of policy. It may be urged that in view of the controversial nature of the question of failure of control measures, the authors would have done well to carry out a preliminary study of the causes of rising prices and to estimate the order of importance in which different factors could be held responsible. This would have lent greater authority to their conclusion and might have brought into clearer light the relationship between the Government's currency policy and the soaring prices. The main lines on which the authors seek a reorientation of policy are indicated in the following lines : "Not only must India be considered as *one* producing *and* consuming unit ; the problem of supply and distribution of *all* food grains must be considered as one whole, if a satisfactory solution is to be attained...... In a word, price control without the control of production and also consumption—which latter means rationing—is not only futile ; it is also mischievous and in-

equitous." It would have been more logical if the authors had also advocated, along with the introduction of *all* food grains, the inclusion of other necessaries of life in the scheme of price control.

The authors have throughout maintained a high standard of rigorous analysis, constructive approach and balanced judgment. Since the problems discussed here are of great topical importance and are likely to become more, rather than less, urgent in the near future, the present study ought to receive careful attention in all quarters. It is a pity that the problem of price control has so far been dealt with entirely in administrative terms, and the authorities have not cared to inform themselves about the essential economic implications of the measures they adopt. The economist has been studiously avoided as a nuisance. No wonder that the authorities find themselves landed in a complete mess, their adventures being hardly less interesting than those of Alice in Wonderland.

N. S. PARDASANI

Indian Economics. By Jathar and Beri. Vol. I, Seventh (Revised) Edition. Oxford University Press, 1942.

THE number of editions into which this work has gone is eloquent testimony of its usefulness. The authors have, in this latest edition, kept up their usual practice of bringing facts and figures up-to-date, and of dealing with the very latest problems in appropriate contexts. The work is a mine of useful information and it sets out the economic problems and policies in this country taking into account the latest Government publications and Reports.

The present reviewer had occasion only a few months ago to review in this *Journal* the latest edition of Volume Two of this work. The observations made there apply to both the volumes, and it is therefore unnecessary to repeat them here.

The revisions and changes made in this new edition of Volume One add to the undoubtedly great value of this work to the student as well as to the business man and industrialist in need of a handy reference book on the varied problems of Indian Economic Life.

J. J. A.

A Text-Book of Indian Administration. By M. R. Palande, M.A. Oxford University Press, 1943.

THIS is an enlarged and a revised edition of a well-known Text-book on Indian Administration. The fact that this is the ninth edition is a sufficient testimony to its utility. The book, as its title frankly states, is a "text-book"—not an original, nor a critical, nor a constructive, nor even a deep or a penetrating study. Its strong point is its easy, narrative style. The book is well-planned, gives the necessary information under appropriate headings and supplies the historical perspective to the present system of administration in India. The treatment

is not rigorous and there is a slight tendency to verbosity. What is required in the next edition is not any further increase in size but a more rigorous and scientific treatment and a careful discussion of the working of the various parts of the Indian administrative machinery.

G. N. Singh

Report on the Economic and Nutrition Survey of Gujarati Middle Class Families in Bombay City.

IT was felt that the Gujaratis were, in natural build and inferior to the people of some of the Provinces of India and to those of the other countries. The Gujarat Research Society formed a Committee consisting of Economists and Medical men to investigate the subject. A donation to meet the expenses was secured from Sir Purshottamdas Thakordas. The Report on Economic and Nutritional Survey of Gujarati Middle Class Families in Bombay city is the result of this Committee's work extending over a period of a year during which they obtained economic data of 380 families and examined 193 families comprising of 697 members for information on their nutrition and health. The field of inquiry has been restricted to the Hindu Vegetarian Gujaratis, but it includes Cuchhis and Kathiawaris. The purpose of the inquiry was to find out whether the diet of the Gujaratis had any bearing on the natural build and physical development ; but the Committee has gone beyond this and tried to find out by studying their economic condition, the causes of the inadequate and deficient nourishment and also has tried to study the effects of deficiency diet in producing certain diseases in the community.

To include the study of economic condition of the people in a nutritional survey is unusual but if the inquiry is meant not only to find out the state of affairs regarding the nutrition of a people but also to show the ways and means to improve the deficiency, an economic survey is very essential, as the quantity and quality of the diet of the people always depends on their purchasing power. This Committee therefore deserves credit for striking at this unusual but very necessary procedure adopted. One hopes that future inquiries taken up for nutritional survey of a group of people or of a nation must incorporate the examination of their economic state. A number of recommendations of the League of Nations regarding the nutritional standard and health problems have not been implemented in India because the economic condition of the Indian people was not taken into consideration by those who proposed to adopt those standards in India. Unless the economic condition improves, the ideals cannot be reached.

The first part of the inquiry, therefore, consists of the study of the economic condition of the Middle Class Gujaratis in the Bombay City. This study has shown that the income of 50 per cent of the earners in the group is below Rs. 50/- a month. 39 per cent earn between Rs. 50 to Rs. 100/- while only 11 per cent of the community earn more than Rs. 100/-. The dependents on an earner are 3.4, 2.4 and 4.7 in the respective scale. Thus the man with small income has a big family to support. The inquiry into the distribution of his expenses shows that a big portion of the income (21%) of a man earning Rs. 50/- per month

is to be spent after rent of the premises. Meeting the expenses on the clothings and sundries which include social expenses very small amount is left to be spent on food, education and health. The inquiry shows that one earning Rs. 50/- per month spends about 47.1% of his income on food, but there seems to be some fallacy because later on it is shown that this man maintains himself by borrowing. If his income and his borrowed loan are taken together, the expenditure percentage on his food will fall. Housing conditions are inquired into with some details, as the conditions under which he lives influence his health. About 50 per cent of the community stay in small ill ventilated and badly lighted rooms, situated in a thickly populated locality. Others are in better but still unsatisfactory tenements. It is only 24 per cent of them have satisfactory accommodation. Floor area per person available is 50 sq. feet and in some cases less. The standard suggested by the Committee is 90 sq. feet for each person and 270 sq. feet divided into 3 rooms for a family of 2 adults and 2 children below 14. The rent charged per 100 sq. feet is Rs. 7/6 which is considered very high. The minimum accommodation suggested by the Committee will cost so much that under the present circumstances it would be beyond his means. He pays this heavy rent by making a cut on his food expenditure. Thus the high incidence of rent depresses the present standard of consumption to a considerable degree and at the same time endangers the future consumption. The unsatisfactory health of 69 per cent of the persons is attributed to unhygienic conditions under which they live. How much blame be apportioned to this factor is difficult to determine as many others like nutrition, habits, nature of work and working hours have influence on the health ; but there is no denying the fact that next to nourishment the most important factors for health are good light and fresh air in the houses of the people. At the close of the economic survey it is submitted that one per every four families is in a state of indebtedness. More than two thirds of the debt is incurred to meet the monthly expenses while remaining one third only for social ceremony and ancestral debt.

The second part of the report deals with the nutritional survey. It consists of (1) Finding out the various types of food stuffs used, measuring the daily consumption, calculating the daily quantity into calories and reducing it to a consumption unit, (2) Physical condition and general health, (3) Relation of diet to the state of nutrition. The method adopted is described. The raw food stuffs for one day's consumption for the family were measured. The nutritional values were then calculated according to the scale fixed by Nutritional Research Laboratories for Indian Dietary. Those values were then reduced to man value or consumption unit per day. The food stuffs were weighed only for one day for one family and not carried out for seven days as recommended by the League of Nations Nutrition Committee. In the investigation the scale of average calory requirements suggested by the Government of India's Health Bulletin No. 23 has been employed in transforming the family diet in terms of food stuff and chemical composition per man value or consumption unit, the unit being the requirements of an adult man doing moderate work.

The Gujarati diet is purely vegetarian consisting of wheat, bajari, rice, pulses, vegetables, ghee and vegetable oils, jaggary, sugar and milk. Attempt is made to find out how much proteins, carbohydrates and fats, salts and vitamins he gets from his food stuffs and the total

nourishment of each individual in terms of calory value. The average intake of Proteins is 56.5 gms. per consumption unit per day, the normal being 65.70 grms. according to Health Bulletin No. 23. 58% of the families take less than 60 gms., 23.8% less than 50 gms. and 6.7% less than 40 gms. The diet therefore does not supply adequate quantity of Proteins. Of the Proteins 11.7 gms. form animal Proteins derived from milk only. Milk is included in the diet of a small proportion of the people. 91.7% of the families take less than 20 gms. of animal Proteins and 40% less than 10 gms. The intake of animal Protein increases with the increase in the income, carbohydrates being cheaper than Proteins and fats, the poor man makes his energy requirements by increase in the consumption of carbohydrates. As the income increases the intake of carbohydrates decreases. The average supply of energy from his carbohydrates is 54.45%.

The average intake of fats by the Gujaratis is 94 gms. per consumption unit per day out of which 59.7 grms. are animal fats. This is higher than in many provincial diets in India, but is less than what an average Englishman takes. Mineral intake is adequate on an average. Its intake increases with the increase in income. Calcium intake is 988 mgms. of which 570 mgms. are derived from milk and milk products. Only 12% of the families take less than 680 mgms.—the standard reqirements. The diet supplies 1351 mgms. of Phospherous. According to Sherman, Calcium and Phospherous ratio should be between 1:1 to 1:2. The Gujarati diet therefore provides them within the limits of this ratio. The supply of Iron in the diet is more than 30 mgms. per day which is quite adequate. Vitamin A is deficient. The average supply is 1712 units while the normal requirements recommended by the League of Nations are 3000 units. In this the Gujarati diet is definitely defective. Vitamins B and C are supplied in adequate quantity. The average calory value per consumption unit per day supplied by a Gujarati diet is 2500 which is less than the normal and a large portion of it is derived from the carbohydrates.

The survey of Physique and Health was made on 1031 subjects who were weighed and measured. 433 males, 232 females, 28 boys, 30 girls and 208 children were examined. Their weight and height were compared with children of the same age from various parts. The Gujarati children were shorter and lighter than Sikh but heavier than South Indians. There was no significant difference between the weights and heights of the Gujarati and those of the Delhi province. The diet of the Sikh is better and of the South Indian poorer than that of the Gujaratis. Delhi and Gujarati diets are very much similar. The weight of a Gujarati is about 15.25% below that of an American. In assessing the health they have classified the subjects in three grades : (1) Good ; (2) Fair ; (3) Poor. In absence of Indian standards for height and weight available for all ages, American standards were employed. Weight 15% below or above the American standard was considered "Good." 15 to 25% below it as "Fair" and others "Poor." On this basis 31.7% were typed as Good and 68.3% as Fair or Poor. It was noticed that with higher income the percentage of Good increased. This showed that 68.3% of the Gujarati Middle Class was below par in physical health. This is attributed to deficiency and inadequacy of the diet. This assertion to be true needs further investigation and experimentation because

besides the diet many other factors like climate of the place, habits and customs of the people are likely to influence the growth and development of the body. An experiment to study the growth and development of a particular diet with equal number for control under the same conditions of living is necessary to draw conclusions.

They have tried to find out if the Gujaratis suffered from diseases due to deficiency in diet. Stomatitis and Anæmia were noticed, particularly in women, but this part of their study was very limited, and only visual. Deductions therefore will not be justified. The findings that there were more persons in the class "Good" amongst those whose income enabled them to include milk and green vegetables in their diet supports their assertions.

It is also true that both the animal Proteins and Vitamin A are body building and growth developing constituents of food. The Gujarati diet is found deficient in both as well as in total Protein, and to that extent the Gujaratis are likely to be inferior to other people who were provided with adequate nourishment.

At the end, the report deals with the cost of a standard diet. The cost of a standard diet based on the calory requirements will vary according to the type of food stuffs consumed to get the required calories. The cost will be small if the entire calory requirements are obtained from carbohydrates and vegetable fats while if they are obtained from animal Proteins and fats, *i.e.*, from milk and its products and green vegetables the cost will rise. They calculated that at the prices current in 1941 the cost of a standard diet of Gujarati Middle Class should cost Rs. 14/8 per man per month. This is very much higher than that of Rs. 5/6 of Dr. Aykroyd for South Indian Diet, Rs. 7/8 of the Bombay Textile Labour Inquiry Committee, Rs. 7/6 of Dr. Tilak, and Rs. 7/5 for vegetarian and Rs. 9/8 for non-vegetarian diet worked out by Dr. Erulkar. All these standards are worked out on diets of working classes who can take large quantities of carbohydrates to get enough calories. The middle class Gujarati has to resort to food stuffs which would give greater nourishment from small quantities of food. Such food stuffs cost more and that is the reason why the cost worked out by the authors of the Report is high.

Considerable pains have been taken by Dr. M. H. Patel and Dr. V. V. Shah in carrying out the investigation and in sorting out the data. The Report makes very interesting reading, full of informative and thought provoking material, but from the facts gathered by them the Gujarati middle class diet does not seem to be much below the standard. Excess of vegetable fat and deficiency of animal Proteins and fat will not be difficult to adjust in a daily diet. There are some mistakes in marking tables which could have been corrected in proof reading and omissions of Tables and Graphs referred to in the body of the Report. The material analysed is rather small for definite conclusions. But for this the Report is well written and is likely to prove useful to the workers in the field and to the people concerned.

CHAMANLAL MEHTA

LIST OF THESES

Table showing M.A. and Ph. D. Graduates in History, Economics and Sociology from 1st January 1943 to 30th June 1943, with the titles of their theses, etc.

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate Worked	Name of the Institution
	M.A.		
	History		
Debara, A. K. (Mrs.)	James Outram, Political Agent in Sind	Professor W. Coelho	St. X.
Merchant, K. K. D.	Bombay, Baroda and the Pirates of Kathiawar (Late 18th and Early 19th Centuries)	Professor W. Coelho	St. X.
	Ph. D.		
	History		
Karmarkar, A. P.	Development of Dravidian Religion in Ancient India	Rev. H. Heras, S.J.	St. X.
	Economics		
Dhekney, B. R.	Studies in Municipal Finance in Bombay Presidency	Professor D. R. Gadgil	G.I.P.E.
	Sociology		
Desai, I. P.	Social Basis of Crime	Professor G. S. Ghurye	U.E.S.
Gandhi, K. H.	The Social Thought of Havelock Ellis	Professor G. S. Ghurye	U.E.S.
Majmudar, M. R.	Cultural Background of Gujarat Art—Especially its Art of Miniature Paintings	Dr. N. A. Thoothi	U.E.S.

CORRECTION

In "The Maratha-Portuguese War of 1683-84," by Professor G. M. Moraes, appearing in *Journal of the University of Bombay*, Vol. XI, (New Series), Part 4, January 1943, page 47, Note 115, *for* 1685, ***read*** 1635.

BOOKS RECEIVED

Bombay—1940-1941 : A Review of the Administration of the Province.

Report of the Annual Statistics of the Stamp Department in Orissa for the year 1941-42.

ACKNOWLEDGMENTS

Bulletin of the Deccan College Research Institute

Empire Cotton Growing Review

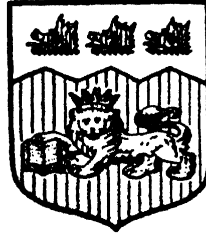
H. L. College of Commerce Magazine

Indian Information (English, Hindi and Urdu)

Southern India Commerce

Sydenham College Magazine

Journal
OF THE
University of Bombay



[ARTS AND LAW NUMBER: NO. 18]

VOL. XII (New Series) SEPTEMBER 1943 PART 2

CONTENTS

ARTICLES :

REVIEWS :

SOME SOCIAL AND LITERARY CRITICS AND MORALISTS OF THE EARLY EIGHTEENTH CENTURY

By

PROFESSOR K. L. JOSHI, M.A. (LOND.),

S. L. D. Arts College, Ahmedabad

I

THE work of three journalists, John Trenchard, Thomas Gordon and Bishop Hoadly in the *London Journal* during the years 1720—1728 was discussed in the article "Three Journalists of the Early Eighteenth Century."[1] The *London Journal* also published some interesting contributions of social and literary critics and moralists particularly during the years 1725—1728, and it is intended in this article to describe and discuss the work of these men. A good many of these contributions were of a controversial nature, forming an interesting background to the literary and social history of early eighteenth century.

Among these writers were Francis Hutcheson and Gilbert Burnet who contributed to the *London Journal* from March 27, 1725, to the end of the year under the names of 'Philanthropus' and 'Philaretus' respectively. The controversy between the two men was of a philosophical nature and as admitted by Burnet in the preface to the edition of collected letters published in 1735,[2] "in this controversy the Rules of candor[sic] and Good Manners have not been transgressed, thro' an impatient zeal for our respective sentiments."[3]

Gilbert Burnet, M.A., (1690-1726), was educated at Leyden and Merton and contributed to *Hibernicus Letters*, a Dublin periodical (1725-27), and to Ambrose Philip's *Free Thinker* (1718-21). In the 'Bangorian controversy' he supported Hoadly, and this was probably the reason why he wrote in the *London Journal* when it was under the direction of the Bishop. There are a few more letters[4] of 'Philaretus' in the *Journal*, not belonging to this controversy, and it is possible to suggest that they were written by Gilbert Burnet, though there is no other evidence to warrant it. 'Philaretus' does not appear in the *Journal* after 1726, the date when Burnet died, and this fact is in favour of the probability that the earlier

1 "Three Journalists of the Early Eighteenth Century," by Prof. K. L. Joshi, *Journal of the University of Bombay*, Vol. X, Part 2, Sept. 1941.

2 "*Letters between the late Mr. Gilbert Burnet and Mr. Hutchinson* [*i.e.*, Hutcheson] *concerning the true foundations of Virtue or Moral Goodness. Formerly published in the London Journal; to which is added a Preface and a Postscript wrote by Mr. Burnet some time before his death.*" London, 1735, 85 pp.

3 *Ibid*, pp. iv-v.

4 *e.g.*, 'Philaretus' in the *London Journal*, March 2, 1722/23; March 23, 1722/23; Sept. 18, 1725, "on Enormities in the Public Papers."

letters of 'Philaretus' were written by him. He was prebendary of Salisbury from 1715 until his death on June 17, 1726, and was chaplain to the King from 1718.

Francis Hutcheson[5] (1694-1746) was a close follower of the third Lord Shaftsbury and has an important place among the English Moralists of the eighteenth century. He studied Philosophy, Classics, Literature and Theology in Glasgow for six years from 1710.[6] Upon leaving the University, he went to Ireland, where he received a license to preach, and his literary accomplishments soon made him generally known at Dublin. Among others, Lord Molesworth assisted him with advice and criticism in his aesthetic and philosophic inquiries.[7] He published anonymously while residing in Dublin four essays by which he is well known now, *The Inquiry Concerning Beauty, Order, Harmony, Design*, and *the Inquiry Concerning Moral Good and Evil*,[8] in 1725, and *the Essay on the Nature and Conduct of the Passions and Affections*, and *Illustrations upon the Moral Sense*, in 1728. It was these writings that provoked the controversy and criticism in the *London Journal*.

In 1729, Hutcheson was elected to the Chair of moral philosophy at Glasgow ; and "from his arrival at Glasgow, in 1730, until his death in 1746, he published nothing of moment."[9] A few pamphlets and treatises were published during this period, but it could be said that the rest of his life was spent in the assiduous performance of the duties of his professorship. His philosophical reputation rests on the four essays and a few letters, including those in the *London Journal*, all published during his residence in Dublin.

A short notice of Hutcheson's *Inquiry into the Original of our Ideas of Beauty and Virtue* appeared in the *Journal* on March 27, 1725, in the form of a letter by 'Philopatris' to 'Britannicus.'[10] "You see," says the writer, "the Author does not exclude the Pursuit of *our* own Happiness ; but is labouring to found Virtue upon something more *divine*, and exalted, than *self-love*." He then proceeds to "other affections, as Fear, or Reverence, arising from an Apprehension of Goodness, Power and Justice," and then goes on to answer "the principal Objections against his Notion." The article does not pass any opinion on the argument of Hutcheson, but gives long extracts from the work and at the end expresses hope that the *Treatise* may revive and excite in men of fortune and leisure the study of the philosophy of *Virtue* and the nature of *True Religion*.

5 Full account of his teaching, etc., is given in Prof. Thomas Fowler's *Shaftsbury and Hutcheson* (1882) ; and W. R. Stott's *Francis Hutcheson* (1900). See also, Bain, A., *Mental and Moral Science*, pp. 580-93; Leslie Stephen, *History of English Thought*......, Vol. II, pp. 56-63.

6 Fowler, *Shaftsbury and Hutcheson*, p. 170.

7 *Ibid*, p. 172.

8 The original title of this, in its first edition, which was altered in the second edition in 1726 was—*An Inquiry into the Original of our Ideas of Beauty and Virtue in Two Treatises, in which the Principles of the late Earl of Shaftsbury are explained and defended against the Author of the Fable of the Bees ; and the Ideas of Moral Good and Evil are established, according to the Sentiments of the Moralists, with an attempt to introduce a Mathematical Calculation on Subjects of Morality.*

9 W. R. Scott, *Francis Hutcheson*, p. 1.

10 'Britannicus' is Bishop Hoadly, 'Author' of the *London Journal*, during this period. See "Three Journalists of the Early Eighteenth Century," *J. U. B.*, Vol. X, Part 2, Sept. 1941, p. 38.

This was followed in the controversy by eight letters, five[11] of which were written by Gilbert Burnet as 'Philaretus' and three[12] by Hutcheson as 'Philanthropos.' The controversy itself is hardly of much significance, for Burnet accepted the thesis of Hutcheson, but found a few gaps in Hutcheson's reasoning which he pointed out in these letters.[13] "In the Inquiry into Virtue," says he, "I apprehended that the beautiful structure the author had raised, wanted a sufficient Foundation. And tho' the Conclusions were generally *True* and *Right* in themselves, and were capable of Demonstrative Proof, yet he seemed to me to have left them unsupported."[14] He thought it was necessary to make a "further and deeper search into the Bottom of Virtue in order to discover the true and solid Foundation of it."[15]

Burnet's criticism was based on the writings of Bishop Cumberland and Dr. Clarke,[16] and it applied more especially to the earlier editions of Hutcheson's works that Burnet had before him containing the mathematical formulae. Hutcheson replied to each letter, and attempted to define and explain carefully the use of such words as *Reasonable*, *Fit*, *Right*, *Just*, *Conformable to Truth*, etc.[17] What is very significant of the discussion is that it continued very amicably, both of the disputants adopting a "gentlemanly and truly philosophical manner of writing."[18] At the end, it seems Hutcheson found that he could not give sufficient time to the preparation of his replies, and he finally wrote to Burnet privately, saying that he was prepared to continue the discussion later when he hoped to have more leisure.[19] The death of Burnet in June 1726 ended the further development of the correspondence and the letters and replies with an additional note and preface were published in 1735. The controversy itself is unimportant and both, Fowler and W. R. Scott, make only a passing reference to it.[20] Prof. Fowler sums it well by saying that "the controversy proceeds throughout on the assumption of the truth of what would now be called the Utilitarian or Greatest Happiness Theory. The only question between the disputants is whether the ultimate principle of action is given by a sentiment, as is maintained by Hutcheson, or by an intuition on the reason, as is held by his opponent."[21]

It is not a surprise to notice the subject of morality pursued by other writers in the *London Journal*. One 'Philalethes,' for example, gives his reflections on the subject in a well-argued article in the *Journal*, July 23, 1726. His discussion is based on the moral theory of William Wollastan (1660-1724) whose *Religion of Nature Delineated*, (1724), he mentions

11 *London Journal*, Ap. 10 ; July 31 ; Aug. 7 ; Nov. 27 ; Dec. 25, 1725.

12 *Ibid*, June 12 ; June 19 ; Oct. 9, 1725.

13 *Letters between Mr. Gilbert Burnet and Mr. Hutchinson*, London, 1735, Preface, p. iii.

14 *Ibid*, pp. iii-iv.

15 *Ibid*.

16 *Ibid*.

17 *The London Journal*, June 12 ; July 31 ; Aug. 7, 1725.

18 *Ibid*, June 12, 1725.

19 Hutcheson, *An Essay on the Nature and Conduct of the Passions and Affections......*, 1728 ; Preface, p. xx.

20 See Fowler, *Shaftsbury and Hutcheson*, p. 189. W. R. Scott, *Francis Hutcheson*, pp. 51-52.

21 Fowler, *Shaftsbury and Hutcheson*, pp. 189-190.

with respect. This work, as we know, in its turn was substantially a repetition of Samuel Clarke's theory of morality.[22] The discussion is carried on in the form of objections raised and answers given to each of them.

Again, when Hutcheson published in 1728 his *Essay on the Nature and Conduct of the Passions and Affections with Illustrations on the Moral Sense*, a writer who calls himself 'Zeno' takes notice of it in the *Journal*, Feb. 24, 1728 (No. 447), and shows his interest in Hutcheson's examination of Wollaston. He would be pleased, he says, once more "to see a good-natur'd Correspondence begun to these subjects in your paper, [he is writing to the 'author' of the *Journal*] or elsewhere, and unless the author of the Essay himself superseded my weaker Endeavours, [I] would not grudge any Labour it would cost me to bear a Part in such a correspondence, with any gentleman who would suggest another scheme independent of our author's. I should be glad to see *Philanthropus* again in your *Journal*, which would make you sufficient amends, that you received no more upon the subject, from me ; I was to raise up another *Philaretus* to provoke him to it."

Accordingly a new 'Philaretus' did rise up, and in No. 450 of the *Journal*, March 16, 1728, writing to 'Zeno' he says, "your desire of raising up a new *Philaretus*, has induced me to assume a name honoured with his choice ; though I do not pretend strictly to enter into all his notions much less to take up the controversy between him and *Philanthropus* where he left it."[23] But this, as well as another article about Hutcheson's work in No. 468 of the *Journal*, July 20, 1728, by one 'Philocalus,' in which the writer defends Hutcheson against certain attacks, did not provoke the latter to contribute to the *London Journal*, and the matter seems to have ended there.

II

The first of the eight letters written by Mathew Concanen in the *Journal* under the name of *Philonomous*, appeared in Number CCCXXIX, Nov. 13, 1725, and the last appeared on June 11, 1726. Some Shakespearean criticism of Theobald that was published in the *Journal* about the same time,[24] has been also attributed to Concanen's introduction[25] (*e.g.*, Theobald's letter, which he introduced eulogistically on Sept. 3, 1726).

All the eight letters of *Philonomous* were included in one volume, *The Speculatist, a Collection of Letters and Essays, Moral and Political, Serious and Humourous : upon Various Subjects*,[26] which contains some of his contributions to the *British Journal* and the *Speculatist* along with those to the *London Journal.*

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22 Leslie Stephen, *History of English Thought*......, I, p. 130.

23 'Aletheiophilos' writes about the same work of Hutchinson in the *Journal*, No. 463, June 15, 1728 ; but the criticism is not very significant.

24 *e.g.*, Theobald's letter, Sept. 3, 1726 ; 'A.B.' praising Theobald's work, *Journal*, May 28, 1726. See Sherburn, *A. Pope*, p. 224.

25 Nichols, *Illustrations*, 1817-58, Vol. II, p. 189. Article in the *D. N. B.* on Concanen, by Leslie Stephen.

26 The British Museum has the second edition of this volume published in 1732.

Mathew Concanen (1701-1749) was a typical example of the talent employed and rewarded by Walpole. He came from Ireland,[27] and deserted law for miscellaneous writing, including some comedies and poems.[28] He is reported to have taken to hackwork in literature and to have decided by the toss of a halfpenny to defend the ministry, while his friend J. Sterling, along with whom he came to London, was to be in the opposition. He sought the favour of the Court, became known to Sir William Young[29] and was appointed by Walpole as a writer in the *British Journal* and the *London Journal*. He showed great zeal for Walpole in the *Speculatist*, which he wrote in 1730, and expected further advancement from the minister. The author of *Verres and his Scribblers*, which is an amusing satire on Walpole and his hirelings, makes naught of his ability. "He came over from Ireland," says he, "friendless, pennyless, unknowing and unknown; without genius for any science, liberal or otherwise; without any parts mechanical or natural, to live upon his wits."[30] In the poem he says,

> "From poor *Hibernia's* shore *Mamurra*[31] came
> Thin was his Form, and thinner was his Fame.
> A starveling shade, unknowing and unknown,
> The Goddess *Hebes* laid him to the Town:
> 'Here son,' she said, "This is the spot to thrive,
> Beg Paper, borrow Pen and Ink, and live.
> Behold, around, my numerous Offspring crowd,
> And grateful me their Parent own Aloud.
> ....
> Obtuse thy Wit, and torpid is thy Scull,
> Immers'd in Clouds, impenetrably dull;
> Rouse up and with the Ministerial Band,
> My favour'd children, take the first Command."[32]

And also,

> "Therefore a while to the Poetic throng
> Ungifted, uninspir'd *Mamurra* clung,
> Flatter'd poor writings for his daily Bread,
> And on the Gleanings of the Muses fed.[33]

Concanen was a great opportunist and he was admitted to the select circle of the *Daily Courant*.[34] In 1732 this "cold, longwinded native of the deep"[35] gained the post of attorney-general of Jamaica.[36] He had abused Pope and Swift,[37] and the *Grub-street Journal* took every occasion to decry him. Its number of Sept. 3, 1730 declared the *Speculatist* to be a fraud on the subscribers, since it was "no other than a wretched

27 Nichols, *Literary Anecdotes*, Vol. V, pp. 534-535.

28 Nichols, *Illustrations*, Vol. II, pp. 189-192, gives a fairly full account of Concanen, most of which is also found in the *D. N. B.*

29 *Ibid*, p. 191.

30 *Verres and his Scribblers*, 1732, p. 64.

31 *i.e.*, Concanen.

32 *Verres and his Scribblers*, pp. 27-28.

33 *Ibid*, p. 28.

34 Pope in a note of 1736, on Concanen.

35 Pope, *Dunciad*, II, pp. 299-304.

36 Nichols, *Illustrations*, Vol. II, p. 191.

37 *Ibid*. In the *Speculatist* are found two of Concanen's Essays which stirred Pope's ire; "On Pope's Miscellanies, Nov. 1727," and "On Frauds of Booksellers," which Pope answered in the *Grub-street Journal*, Numbers 32, 35, 38, Aug.-Sept., 1730.

relique, patched up from the wrecks of the *British* and *London Journals.*" And the *Grub-street Journal* of Sept. 7, 1732, was indignant at Concanen's legal appointment in Jamaica. A poet wrote in it :

Come Dunciad authors, come to dinner all,
C—'s made attorney-general.
Think not this honour a mere act of grace ;
His noble talents justly claimed the place :
For all attorney-generals, till of late,
Were ever famed for legal Billingsgate,
And he that used the turn-coat Lord of Dawley[38]
In the same style that Coke of old did Rawley,
Goes to restore in climes from Britain far,
The ancient elocution of the Bar.[39]

The eight letters of Concanen in the *London Journal* were concerned with the "Reformation of the Law." The main function of all human laws, according to 'Philonomous'[40] [Concanen], is "to secure the Weak, either in Mind or Body, from the open Force, or secret Stratagems, of the Strong and Subtle." And for this purpose, he thinks, "the Laws should be as few, as coercive and as certain as possible. Many Inhabitants and few Laws, are the great Happiness of a state. But when the Power of those Laws is dreadful, and the Certainty conspicuous, they are an Insurance for the Permanence of that Happiness." His suggestion,therefore, was to amend the law into a plain and useful system. Continuing this question of "Contraction and Amendment of the Law," he gives a few illustrations to this point in his next letter.[41] He dwells on the tricks of "the science of good Pleading," and "those pitiable *quirks* and Evasions, . . . and the mystery of playing the weapons well." He also attempted to "awake others to think, if possible, of some Remedy to the Delay of Justice ; a Misfortune so great, that the fine judging *Shakespeare* makes *Hamlet* reckon it up among those insupportable calamities which might tempt a sensible Man to throw off life ; and to help to bring our courts of *law* to the nearest Resemblance an earthly Judicature is capable of, to *that* above ; of which the same admirable Poet says,

There is no shuffling ; *There* the Action lies
In its true Nature—."

Discussing in the next letter the question of criminals and the justice meted out to them in England at the time, he again dwells on reforms. "The manner of preparing criminals for Death amongst us, calls loudly for a Reformation. In Holland the prisons are so well inspected, that no Riot or Debauchery can enter into them." He is very much against the "long Delay of the Execution of a just sentence;" and takes this occasion to support the Bill "now depending for preventing frivolous and vexatious arrests," as a natural piece of justice.[42] A whole article is written about "Distributive Justice,"[43] with learned historical illustrations. Dwelling mainly on the unfairness in the administration of Justice, he says, "This Institution, which at first appeared the best that human

[38] *i.e.*, Bolingbroke.
[39] *Grub-street Journal*, Sept. 7, 1732.
[40] *London Journal*, Nov. 13, 1725.
[41] *London Journal*, March 12, 1725-26.
[42] *Ibid*, Ap. 2, 1726.
[43] *Ibid*, Ap. 9, 1726.

ingenuity could form, has at length become destructive of its own Purpose,................. nor do I doubt but such methods will be provided, that we may not at any Time hereafter, have occasion to complain with Solomon, 'Behold the Tears of such as were oppressed, and they had no comforter ; And on the side of their oppressors there was Power; but they had no comforter.' " Writing of stock-jobbing,[44] so seriously complained of at the time, as a very great grievance, he criticises strongly the "practice of buying and selling for a future Day" and asks law-makers to provide against "a growing evil."

Having treated in the earlier letters of the "Laws and Government of this country," he goes in the next two letters to examine and expose "their strange prejudice of Education which teaches us to neglect and contemn what is the most useful in every Degree of Life."[45] In this essay on the study of the Law, he gives illustrations of Education of Ancient Greeks and Romans ; how, "every man in his youth made himself Master of moral Philosophy and the Laws of his country, all the learning then in vogue ; for foreign languages were not then as now, the study and perplexity of youth," and his valuable suggestion is quite prophetic. "If there were Professors," he says, "of this useful knowledge, as there are of other sciences, in all the *British* Universities ; the Bar, and the qualification for it, might be left still to be the care of the *Inns* of Court. But then it might be so contrived, that young gentlemen, while they are going through what they call studies, may take such a Tincture of this general knowledge of our constitution and of our own Laws, as may render them not altogether strangers when they enter into the character of Lawmakers."

In the last[46] of this series of essays, Concanen dwells on "the Preservation of our Law." And though, he says, there were numberless censures thrown upon the Management of the Law and objections made to the administration of Justice, he believed in the principle of Law and what he demanded was the reform of it. "It will be a National Praise to us," he says, "when it is said Abroad, that the British Legislature have taken care to make good to the Distressed, a sum of above Eighty Thousand Pounds, which the mismanagement of a few Men in Places of Trust had dissipated."[47]

Though Concanen was criticised by his contemporaries as a hackwriter and probably evoked jealousy for the way he procured advancement, yet these essays, as well as others in the collected volume, may appear to the modern reader as profoundly sensible for the time, showing learning as well as a balance in thought. The copy of the collection in the British Museum, has a manuscript note by a reader, who cannot belong to a date earlier than the early 19th century, from his reference to N. Drake's *Essays : illustrations of the Rambler, 1809*, and the note can be quoted as a reasonable comment upon Concanen's writings. "This is far from being a common book," says the writer, "I never met with another copy.—It

44 *Ibid*, May 7, 1726.

45 *Ibid*, May 21, 1726.

46 *Ibid*, June 11, 1726.

47 One *Philanthropos* writes in the *London Journal*, Sept. 10, 1726, supporting the observations of *Philonomous*, and suggests "Reform of Laws and justice for checking Felony."

is noticed by Drake in Vol. I, *Essays illustrative of the Rambler*, somewhat slightingly, but is evident he had never seen the work for he does not even mention the dates of the papers, or that of the Volume in their collected form. *Mathew Concanen*, a Barrister (*C.* obtained the distinction of being enrolled in the Dunciad) was the writer."

III

During this period, one 'Momus'[48] seems to be the dramatic and art critic of the *London Journal*. By his observations upon the *Taste of the Town* he had already gained, he says, "the Character of a very perverse, ill-natured Fellow............I take particular Pleasure in finding Fault especially with Great Men. I am always out of Humour when I find myself pleased."[49] He considered it his business "to criticise upon the Actions of Mankind, and hunt after Food for his Indignation."

He found that there was a lamentable degradation at the time in "Polite Learning and true Wit, and especially in Dramatic poetry, not only below the ancient Greeks and Romans ; not only below the first writers of our own country, but even below the worst of those who went immediately before us."[50] He attributes the "shameful degeneration" mainly to the bad management of the stage. In a remarkable piece of criticism of drama and its main function, he describes the respective attitudes of the advocates and enemies of the stage. "The advocates for drama," he says, "have always urged in its Defence, that it improved the Manners of the People, and encouraged a Spirit of Learning. For these Ends, no doubt, it was first instituted; and it cannot be justified, under a wise Government, upon any other Account........." Enemies of the stage contended that it corrupted the Morals of Men particularly of younger sort, and introduced a general vein of Libertinism and Debauchery into a Nation : So that both parties agreed that *Theatrical Performances* have always had a wonderful Influence upon the Minds of the people which cannot possibly be denied by any, who have least thought upon this subject ; for a well-written play has almost always the same effect upon us, as the action which it represents. Imaginary characters, justly drawn, strike us in some Degrees like real ones ; the noblest Passions are raised by lively Descriptions of them, and judicious copies of Nature affect us little less than Nature itself. In short, by frequently attending the stage, we assimilate to the favourite characters which are exhibited to us there, in the same manner that we acquire a fine *stile* [sic], by reading fine Authors, or learn Good Breeding and polite conversation by associating ourselves to good Company."

'Momus' then generalises that corruption of manners and decay of learning usually result in the corruption of the stage in all countries. He illustrates this thesis from the Drama of Athens and Rome and also points out how the revival of learning in England meant revival of the stage. If Shakespeare and Jonson brought drama "to any tolerable Degree of Purity and Perfection," during the period of the civil war the stage

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48 See, Gray C. H., *Theatrical Criticism in London*, 1795, p. 58. Gray has not been able to identify the critic and has devoted only one *line* to this critic in his scholarly work. "It has not been possible to identify 'Momus'."

49 *London Journal*, July 10, 1725.

50 *Ibid*, Ap. 3, 1725.

disappeared. After the Restoration, it was revived but "after several revolutions (which all things are subject to) it was reduced at last to that miserable Ebb, in which we now hold it." Then he launches his attack on the stage of his time. "It is proper to observe here," he says, "that as all monstrous Absurdities and other Innovations of all sorts, were never introduced at once, but required Time and Industry to obtrude them on the Minds of the People ; so it was impossible to reconcile us to all the Follies which are now practised on the Stage, and imposed upon us for Wit, without long preparation, and without leading us gradually from one silly Invention to another till we become at length quite infatuated and swallowed down the most execrable Trifles under the Name of Diversion."

Discussing some of these inventions introduced on the stage, he mentions firstly, the "Importation of Italian Music" which "though exceedingly agreeable in itself and beyond Expression entertaining, yet has accidentally had an unlucky effect upon a great part of the *Beau Monde*, who have been led by it entirely to give up the Instruction of their understanding to the Edifications of their Ears." Secondly there is the *French Invention* which influenced English Ladies who began "to conceal their natural Bashfulness and take off that Restraint with which they used to converse in Public." The fashion was to talk at random and crack jokes upon they knew not whom. Such a thing could not fail to have the "greatest encouragement from the *Beau Esprits* of both the sexes, who love to hear themselves talk ; and choose to bear a part in the public Diversions rather than sit for three Hours together as auditors and spectators only of the best Play in the World." This influenced the drama unfavourably and some of the comedies of his time, he thinks, were "a jumble of all Ranks, ages, sexes and conditions such as ministers of state and city Prentices; Ladies of Quality and common Punter; Tavern-drawers, Privy-councillors and Running Footmen." As an illustration of this he mentions "the celebrated Mr. H [ey] d [egge] r."[51]

Thirdly, "Dumb-shows" had become popular. "At first," he says, "they insinuated into our Favour in short interludes, and attic Dances, between acts ; which lasted for some years, and meeting with uncommon applause, this encouraged a new set of Wits to rise up and give the last stroke to the old-fashioned writings of the stage, by forming long farces upon this grotesque Model. Nay, we have been threatened with whole comedies in the same way. And thus, at last the stupendous conceits of Harlequin, Scaramouch, Columbine and Pierrot have laughed all the dull, talking Heroes of Shakespeare and Jonson quite out of countenance."

This new dramatic invention was according to 'Momus' of a mixed nature and it was "to owe its present flourishing state to the ingenious contrivances of more Nations than one. The characters are undoubtedly of Italian extraction, being to be found in all their comedies ; but their profound Taciturnity and the surprising Tricks they perform seem to be Improvements of our Northern Genius."

Commending the efforts of the *two houses* [Drury Lane and Covent Garden] in introducing this form of entertainment 'Momus' gives the credit of its first introduction to the *Master of Sadler's Wells* and thinks

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[51] See Pope, *Dunciad*, I, p. 290.

that "the famous entertainment of *St. George and the Dragon* seems to be the original of Dumb shows in England ; from which they have copied and borrowed their Patterns." He also gives credit to two other writers: "I observe," he says, "that R—h [Ralph, James] and Th—d [Theobald?] are certainly the two greatest Geniuses which this age has produced. They work for the two houses and so a balance is kept between them."[52]

Commenting on the number of devices introduced by various men on the stage, 'Momus' says, "We have reached a crisis. . . . For we seem to have exhausted all the Ancients and pillaged all the Moderns. We have plundered the *Greek* and *Roman* Theatres, gutted all the *French Comedies*, *Spanish Novels* and *Italian Farces*. Nay, we are already driven to such shifts, that we have turned Plagiaries upon Drolls and Puppet-shows ; descended to mean thefts from Mountebanks and Posture-Masters and gleaned up the dull Leavings of Wind-mill-hill and *Bartholomew Fair*."

Pursuing thoughts upon the same subject of degeneracy of the stage, 'Momus,' in the next number of the *Journal*,[53] examines "the several Reasons which are urged for exhibiting and frequenting such low and mechanical Diversions."

One of the reasons put forward by critics, he says, was the great dearth of good writers for the stage. To this, his answer is that the dearth of good writers was the result of a lack of encouragement necessary for keeping up any art. "There are no great Places," he says, "nor valuable stipends, annexed to that Profession ; the only way that a tolerable livelihood can be made of it is by the stage ; and if that is shut up from its Professors, the art itself will certainly decline, . . . It ought to be considered farther, that a *Dramatic poem*, with relation to its contexture, is a mechanical thing, like a *Watch* or an *Orrey* ; that it requires a great deal of art to put all its wheels and springs into right motion; which cannot be attained to perfection, without long use and Experience, and that cannot be expected without considerable Encouragement. I will venture to appeal even to our ingenious Harlequin Authors and Scaramouch Wits, whether they do not find, that long Practice, joined with the present Favour of the Town has improved their Genius and corrected their style."

The next argument is that since there were not many good writers, a good entertainment of the kind prevalent on the stage was better than a bad play. The answer of 'Momus' to this argument is that the new entertainments were only comparable to the "sleight of a Juggler, the agility of Morrice-Dancer, or the Movement of a Puppet-shew" and their action on the stage with their "short *Mop Wings, black bags,* and *Windmill-shifts*" were corrupting influences on life; "so many fine Gentlemen, now-a-days, look more like Harlequins and Scaramouches than persons of Fortune and Distinction."

The third argument was that these entertainments were no innovations but could be traced back to the first institution of the stage, the ancient Greek and Roman Pantomimes. "This," says 'Momus' in answer, "is defending of stupidity by discovering of Ignorance ; for the Ancient Pantomimes were no more like our modern Harlequins than the person-

[52] See A. Nicoll, *18th Century Drama, 1700-1750*, pp. 350, 358-9.

[53] *London Journal*, Ap. 17, 1725, Number CCXCIX.

ating of *natural* characters, and mimicking probable actions, are like inventing unnatural characters and performing the most monstrous improbable actions ..... Are we obliged to imitate the Antients in Absurdities, as well as their Beauties ?"

The last of the arguments was that the 'Buffooneries' were "agreeable to the Taste of the Town, and it is their interest to comply with that." 'Momus' argues that the Taste of the Town should not be taken to mean the "opinion and good liking of school-boys, city prentices and Old Women." Men of sense did not seem to approve of them and even the "Beaux and the Belles, who frequent them most, pretend to dislike them." Moreover he says, "The management must be above promoting their own private Lucre, by propagating of Folly and Nonsense. To this we must ascribe the mad, ranting, rhiming Plays of Mr. Dryden ; whose Necessities obliged him to sacrifice his own good sense, to the prevailing bad Taste of the age, and the Interest of mercenary Comedians. Ben Johnson [sic] is said to have written his *Bartholomew Fair* in like compliance with the then reigning Humour, after all the ill Reception of his Tragedy of *Catiline* ; and all the said stuff which we meet in Shakespeare must be imputed to the same cause."[54]

'Momus' gives his thoughts concerning "the present state of Learning in general" in the next article[55] and dwells on the disposition of the town towards learned men.

Before his time, 'Momus' thought, there was eagerness on the part of young men after new books and "any piece which was tolerably written, was greedily bought up and afforded abundance of speculation." Soon the tediousness of large volumes became a "sort of intolerable Load upon Common Readers." Therefore, *Pamphlets* came into fashion, but soon "as we grew more polite, and consequently more idle, they too were obliged to give place to the more concise Entertainments of Halfsheets and the Dissertations of Weekly *Journals* ; which have also had their Run for some years past; but now even they begin to decline and in a little time I believe it will be thought pedantick to read at all." Discussing the taste of the time, he said that only impertinent short novels pleased the people ; "the Proceedings at the Old Bailey, and the Ordinary of Newgate's account of the Lives of Notorious Rogues ; the Adventures of Robinson Crusoe and the memorable actions of Moll Flanders." The works of Hutcheson and William Wollaston[56] might have been well received, but "their good fortune is owing to nothing but chance." What people preferred most was "gross Blasphemy, broad obscenity and glaring Treason." It was often argued that there was a scarcity of good modern books, like that of good plays ; but that was only an "insupportable contempt of the moderns which proceeds partly from Idleness and partly from Envy." He further continues, "It may not, however, be improper to put these Gentlemen in mind, that the same charge of Modernism has been objected against the best authors of all ages ; and that most of those wonderful Antients (whom for the sake of Reputation, they are obliged to extol) were as much despised by their contemporaries, as our present

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54 *Ibid*, June 26, 1725.

55 Regarding this point he quotes Pope from Preface to Shakespeare to support his argument.

56 *Religion of Nature Delineated* (1724). See *Supra*, p. 184.

writers are now. Surely they have forgot (or perhaps they never heard) that Homer was, in his own Times, no more than a Common *Ballad Singer*, and was obliged to chant his immortal Iliad, in Fragements about the streets, for a Half-penny a-piece ; whilst the Grecian fine Gentlemen rattled by him in their Flaring Equipages, smiling with contempt at the ignorant Rabble, his audience and the dull stuff he was reciting." In conclusion he says, "the Press is now actually in danger ; for no Restraint or Discouragement which the Government could lay upon it, would be half so formidable to all Learning and Liberty, as the present Resolution of most people not to read. And I desire to be indulged this consolation, that if England at present must not be allowed to boast of *one good writer*; yet it will be owned, by the same Persons, that it never was so plentifully flocked with profound critics."

In an article[57] on the relations between Arts and Sciences, 'Momus' distinguished between those for use of mankind, those for pleasure and amusement and those for pleasure and improvement of our minds. He illustrates his remarks with examples of Arithmetic, Mechanics, Navigation, Fortification, Architecture as belonging to the first Category ; Painting and Music to the second ; and History, Philosophy, Oratory and Poetry to the third. The elaborate explanation that follows shows that 'Momus' was familiar with earlier critics and his knowledge of Plato and Aristotle is quite skilfully displayed.

'Momus' delighted in finding fault with and attacking a number of things in life and letters of his time. Such an attack on Defoe's *Robinson Crusoe*,[58] however, is not sufficiently justified. He is provoked to make the insinuation that certain writers invented highly improbable incidents and gives *Robinson Crusoe* as a relevant illustration. Writing of the methods of the news-writers he attacks on their numerous inventions, especially when there was no session of Parliament and as a result a general dearth of news, in consequence of which writers had to invent exciting incidents in order to amuse the people. "Sometimes," says 'Momus,' "a profligate News-writer invents Matches out of his own Head, and publishes them in his Paper, only for the sake of filling up a Paper and supplying another for the next by asking Pardon and making an humble Recantation."

'Momus' is a social critic as well ; and dwells on the "present corruptions and growing iniquities" as signs of a degenerating Time. The blasphemous luxuries, obscenities, and "Modern Roguery, which is formed into a complete system and is founded upon as nice Rules as any other art or science whatsoever"—these become the subject of a critical article.[59] And he gives illustrations of Jonathan Wilde and John Shepherd as "extraordinary instances of English Genius for Roguery...... In short even Gallows hath lost its Terrors and the Rogues bid Defiance to the honest men."

In a controversial subject undertaken by "Several Modern Authors and Pretenders to Criticism," condemning the practice of introducing heathen deities into any poetical composition as incongruous, absurd and

57 *London Journal*, July 3, 1725.

58 *Ibid*, Sept. 4, 1725. See also Lee, *Defoe*......., Vol. I, pp. 400-401.

59 *Ibid*, Oct. 30, 1725.

profane, 'Momus' has assumed a reasonable attitude.[60] He defends the introduction of machinery or supernatural powers in a poem, as it elevates the poem above the level of common prose or historical narrative.[61] "It gives Life and Action to the work ; without which anything of that kind must be very tedious and jejune. For this reason all the best Poets, have introduced these shadowy and supernatural characters into their works, to give a Dignity to their Heroes and raise up a scene of action and Business." The introduction of Pagan Deities into poems was justified because "the Pagan system of Religion seems to be calculated for the Purposes of Poetry more than any other End........ the numberless crowd of divinities, whom they (pagans) set up, [were] not so much to induce Belief as to embellish their poetical writings. ..... I do not look upon pagan Theology as a Religion, but a Poetical system, invented originally by Poets, for their particular art ; it is not so properly the Religion of this country or that country, as the imaginary Faith of every Poet, in all ages, and all Nations, I mean in his Poetical capacity." Moreover, he has one more argument in his favour, that as Poetry consisted chiefly in Fables and Fiction, it could not be improper or absurd to support them with fictitious and imaginary characters. Banishing the heathen names out of the Realm of Poetry, therefore, would mean extirpation of all poetry properly so called. "Christian Religion," he says, "is not framed in any Degree like the Pagan, for poetical Compositions. . . . [It consists] chiefly of precepts of the strictest morality. . . . . For all which Reason our Religion cannot possibly be so commodious for Poetry as the Polytheism of the Antient Heathens." Finally he concludes, "Poets are at Liberty to write in an infinite variety of Forms and Models. The only thing required of them, is to support the character which they take upon themselves ; to preserve an Uniformity of manners in the Persons whom they introduce, without making an incoherent Mixture and jumbling one system of Religion with another."

'Momus' is a philosopher and claims to be a moralist as well.[62] He has also a gift of irony and poignant sarcasm. One of the best essays written in this ironical manner is about "the laudable and useful Endowment called Impudence."[63] He defines Impudence as "a certain Quality of mind, which supports a man in all his words and actions with a teeming confidence of look and gesture ; fortifies the muscles of his Face; removes Diffidence, infallibly prevents Blushing; and in a word carries him on through all opposing Difficulties, without any visible marks of confusion, consciousness of Error or Impression of Shame." After giving illustrations from history, he says, "of all Nations in the World, the English is the most defective in this *valuable* quality being naturally shy, modest, sheepish generation." 'Momus' finally ends this masterly method of damning with mock-praise with the remarks, "I will conclude with this observation, that if what I have been saying be true, *Brass* is certainly the most valuable metal in the world."

(*To be continued*)

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60 *Ibid*, Dec. 4, 1725.
61 Probably derived from Pope : *cf.*, Pope's Preface to Homer.
62 *London Journal*, Dec. 11, 1725.
63 *Ibid.*

A LEGEND OF WORLDLY WISDOM *

(Śatapatha Brāhmaṇa)

I-vii-3-1-8

By

PROFESSOR H. R. KARNIK, M.A., PH.D.,

Khalsa College, Bombay

ELSEWHERE[1] I have laid down the principles under which all the legends in the Brāhmaṇas can be classified. In this short paper I propose to discuss one more legend from the Śatapatha Brāhmaṇa, which appears to belong to the class of legends that convey lessons of worldly wisdom. The legend occurs at Śatapatha Brāhmaṇa I-vii-3-1-8 and may be summarised as follows :—

"The Gods ascended to the Heavenly world by means of the sacrifice. Rudra, the presiding deity of the cattle, was left behind in this world where the Gods spread the sacrifice. As he was left behind he came to be known as *Vāstavya*.[2] The Gods continued their worship and their toils with the same means, *i.e.*, the sacrifice by means of which they succeeded in reaching the Heavens. This *Vāstavya*[2] who was left behind and who was, therefore, excluded from sharing the spoils of the sacrifice, went after the Gods on his own and raising and brandishing his weapon in front of them, rose in the northern direction.[3] The Gods were frightened when they found the terrific God *Vāstavya* threatening them with his upraised weapon. They were afraid that the sacrifice which they were performing, will be destroyed or desecrated by this powerful God with his weapon. They, therefore, appealed to him and requested him not to throw his missile and harm their sacrifice. Rudra said to them, 'I will not hurl my weapon and harm your sacrifice, provided you apportion me a share in your sacrifice.' The Gods agreed to give Rudra a share in their sacrifice. On this promise being given to him, Rudra withdrew his weapon and thus did not hurt anyone. The Gods, to their surprise, however, found that all the sacrificial libations that they had ladled, were already assigned to the different deities and were well nigh offered to them. How, then, to fulfil their promise to Rudra ? They devised a means by which they could set apart an oblation in honour of Rudra. They requested the sacrificing priest to sprinkle the sacrificial dishes in due order with butter, replenish each of them for one additional portion, render them fresh and then to cut off one portion from each of them, obviously for Rudra. The Adhvaryu did as he was told by the Gods and thus Rudra, the terrible but powerful God, was given a share in the Gods' sacrifice."

* For this paper the author is indebted to his *guru* Professor H. D. Velankar.

1 See my paper published in the 'Śarma' Number of the 'Poona Orientalist'.

2 For the derivation and explanation of this term see sections 3 and 14 of the text.

3 The time when Rudra did this, was the time to offer the *Sviṣṭakṛt* offering of the sacrifice. See section 6 of the text.

The legend, as it is clear from its outline, is a fantastic and symbolical tale and explains why an oblation is offered to Agni *Svişṭakṛt* whenever an offering is made to any deity. Rudra or *Vāstavya* as he is called in the legend, to whom an oblation was assigned by the Gods in their sacrifice, is the same as Agni.[4] Śarva of the Prācyas, Bhava of the Bāhīkas, Paşūnām pati, Rudra, etc., of the other peoples, are but the various names of one and the same God, *viz.*, Agni[5] but the name Agni alone is chosen when an offering is made to *Svişṭakṛt* because Agni is regarded as the gentlest of all the names of the Deity while Śarva, Bhava, etc., are ungentle appellations of the God.[6] In a sacrifice the gentle or the auspicious is always to be preferred to the ungentle or the inauspicious. That the name Agni is regarded as the *śāntatama nāman* by the Brāhmaṇa is quite significant. Agni being a sacrificial deity, was most useful to the people in this age in which offering a sacrifice was an activity of the first magnitude. The Brāhmaṇa itself explains how this Agni came to be signified as Agni *Svişṭakṛt.* When the offerings were being offered, the Gods said to Agni—Rudra, "Whatever we have offered when thou wert at the yonder place,[7] make (that) well offered for us." Agni made it well offered for them and hence he came to be known as Agni *Svişṭakṛt.*[8]

The legend, thus, answers to the sacrificial exigency inasmuch as it offers an explanation for an oblation to Agni *Svişṭakṛt,* whenever a sacrificial dish is ladled in honour of a deity and in this it is, no doubt, a symbolical narrative as most of the legends in the Brāhmaṇas are. To me, however, it appears to be more than a mere sacerdotal invention to fulfil a sacrificial exigency. It is more than a fantastical or a flimsical tale. In the expedient employed by the God Rudra to secure a share for himself in the Gods' sacrifice the legend seems to convey a lesson of worldly wisdom which is true of all times. *Might is always right.* What one cannot secure by fair or peaceful means one can get at the point of the sword. One, however, ought to be mighty enough to dictate one's terms to the opponent and the latter have to accept them because the *sword of Damocles* hangs over them. Rudra, a powerful God of the Vedic pantheon, was left behind in this world of mortals when all of his divine colleagues ascended to the Heavenly world by means of the sacrifice they spread out here. The Gods, even in the Heavenly world, continued their sacrificial activity. Rudra, the mightiest of the mighty, was thus, excluded not only from theHeavenly world but even from participating in the sacrifice. The sacrifice was the means to an end and every deity, major or minor, tried to secure a share in the sacrifice. No wonder then that Rudra could not tolerate his exclusion from the Gods' sacrifice. He was enraged and was determined to teach the insolent Gods a lesson for excluding a mighty God like him from their sacrifice. He followed the Gods to the Heavenly world and stood in front of them, brandishing his weapon. To the Gods, engaged in their holy work, the mighty Rudra appeared to be mightier still with his missile shining in their eyes. They began to quake in their shoes. They realised their mistake in excluding a power-

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4—6 See section 16 of the text.

7 *Amutra*, according to Sāyana, refers to the āhavanīya—fire-place; *amutra āhavanīya-deśe āhṛtya ādhārabhūte sati*—Sāyana.

8 "*Yat tvayi amutra sati ayakşmahi tan naḥ svişṭam kuru. tad ebhyaḥ svişṭam akarot tasmāt svişṭakrta iti.*" SBR. I-vii-3-9 *svişṭam=suişṭam.* Such derivations of words we often come across in the body of the Brāhmaṇa-Literature. Here is to be seen the beginning of the science of philology.

ful God like Rudra from having a share in their sacrifice. They knew that if Rudra's anger is not assuaged he would destroy them and their sacrifice as well. If the sacrifice, the means of securing happiness, were to be destroyed, all their labours—all their toils—would come to nothing. They were left with no other alternative but to yield to the terms of the wrathful God brandishing his weapon before them. They granted him a share in their sacrifice and thus averted the evil that was facing them. *Sarvanāśe samutpanne ardham tyajati paṇḍitaḥ.* Rudra, on his part, secured what he wanted at the point of the sword, thus proving that *might is always right.*

The legend, as Eggeling points out,[9] is, further, of considerable interest to us since it gives us the identification of Agni, the 'representative of the divine power on earth in the later Vedic Triad' with *Śarva* of the Prācyas, *Bhava* of the Bāhīkas, *Rudra* and *Paśūnām pati* of the other tribes. It appears from this that Śarva, Bhava, etc., were originally distinct and apparently local deities but here the legend attempts to merge these 'originally distinct and apparently local deities' into the premier God Agni. This is a step towards the unification of the several deities of the Vedic Pantheon, which ultimately culminated in the *monism* of the Upaniṣads. But it is more probable that this identification of local divinities such as Bhava with an important Vedic deity like Agni had something else at its basis. These local deities were probably non-Aryan in their origin and had established themselves among the Aryans owing to the local influence. And the leaders of Aryan society had no other option but to admit these deities into the Vedic Pantheon as the different aspects of some well-known Vedic deity. This same process seems to have been at work when most of the Ātharvaṇic deities were admitted into the Vedic pantheon. On such occasions, prudent leaders are always found willing to be led by their followers rather than lose their leadership. Again, in the fearful nature of Rudra—Agni and in his identification with Śarva of the Bāhīkas we notice the origin of the conception of Śiva in the pantheistic system of the post-Vedic period.

TEXT

यज्ञेन वै देवा दिवमुपोदक्रामन् ॥ १ ॥ अथ योऽयं देवः पशूनामीष्टे स इहाही-
यत ॥ २ ॥ तस्माद्वास्तव्य इत्याहुर्वास्तौ हि तदहीयत ॥ ३ ॥ स येनैव देवा दिव-
मुपोदक्रामंस्तेनोऽएवार्चन्तः श्राम्यन्तश्चेरुः ॥ ४ ॥ अथ योऽयं देवः पशूनामीष्टे य
इहाहीयत स ऐक्षत—अहास्य हान्तर्यन्त्यु उ मा यज्ञादिति ॥ ५ ॥ सोऽनूच्चक्राम; स
आयतयोत्तरत उपोत्पेदे स एष स्विष्टकृतः कालः ॥ ६ ॥ ते देवा अब्रुवन्-मा
विस्रक्षीरिति ॥ ७ ॥ ते वै मा यज्ञान्मान्तर्गताहुतिं मे कल्पयतेति ॥ ८ ॥ तथेति
॥ ९ ॥ स समबृहत्स नास्यत्स न कं चनाहिनत् ॥ १० ॥ ते देवा अब्रुवन्—यावन्ति
नो हवींषि गृहीतान्यभूवन्त्सर्वेषां तेषां हुतमुपजानीत यथास्माऽआहुतिं कल्पयामेति
॥ ११ ॥ तेऽध्वर्युमब्रुवन—यथापूर्वं हवींष्यभिघारयैकस्माऽअवदानाय पुनराप्याययया-
यातयामानि कुरु तत एकैकमवदानमवद्येति ॥ १२ ॥ सोऽध्वर्युर्यथापूर्वं हवींष्यभ्य-
घारयदेकस्माऽअवदानाय पुनराप्याययदयातयामान्यकरोत्तत एकैकमवदानमवाद्यत्

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9 See his Translation, SBE, Vol. XII, Part I, Foot-note 2, p. 201, 1882.

॥ १३ ॥ तस्माद्वास्तव्य इत्याहुर्वास्तु तद्यज्ञस्य यद्धुतेषु हविःषु, तस्माद्यस्यै कस्यै च देवतायै हविर्गृह्यते सर्वत्रैव स्विष्टकृदन्वाभक्तः सर्वत्र ह्येवैनं देवा अन्वाभजन् ॥ १४ ॥ तद्वाऽग्नय इति क्रियते ॥ १५ ॥ अग्निर्वै स देवस्तस्यैतानि नामानि शर्व इति यथा प्राच्या आचक्षन्ते भव इति बाहीकाः पशूनां पती रुद्रोऽग्निरिति ॥ १६ ॥ तान्यस्याशान्तान्येवेतराणि नामान्यग्निरित्येव शान्ततमं तस्मादग्नय इति क्रियते स्विष्टकृत इति ॥ १७ ॥

श. ब्रा. (माध्यन्दिन) १-७-३-१-८

(अ) ...... ॥ १ ॥ अथायं देवो योऽयं पशूनामीष्टे स इहैवाहीयत ॥ २ ॥ ......०र्हुवास्तुनि हि ...... ॥ ३ ॥ तद्येनैव यज्ञेन देवा ... ०मंस्तेनार्चन्तः ... ॥ ४ ॥ अथायं देवो योऽयं पशूनामीष्टे स ईक्षांचक्रेऽहासि वा अन्तर्यन्ति वै मा ... ॥ ५ ॥ सोऽनूचक्राम, स एतमेव काल्मुत्तरत आयतयोपोत्पेदे य एष ...... ॥ ६ ॥ ते ह देवा ऊचुर्मास्थ इति ॥ ७ ॥ स होवाच ते वै ... ०मान्तर्गातेति ते वै मे यज्ञ आहुतिं कल्पयतेति ॥ ८ ॥ तथेति ह देवा ऊचुः ॥ ९ ॥ स ह संववर्ह नास ॥ १० ॥ ते होचुरुपजानीतेति यावतीभ्यो नो देवताभ्यो हवींषि गृहीतान्यभूवन्त्सर्वाणि तानि हुतानि कथमस्मा आहुतिं कल्पयेमोपजानीतेति ॥ ११ ॥ ते हाध्वर्युमूचुर्यथा०... ०घारयेत्येकस्मा ...... कुर्विति ॥ १२ ॥ स यथा० ...... ०घारयत्तदेकस्मा ... . ॥ १३ ॥ ...... ०ज्ञस्याभजत यद्धुतेषु ...... हविर्गृह्णन्ति ...... ०भक्त एवं ह्येनं देवा यज्ञेऽन्वाभजन् ॥ १४ ॥ तदग्नय इति क्रियते ॥ १५ ॥ अग्निर्वाव स देव० ... नामानि यथा प्राच्या आचक्षते सर्व इति यथा बाहीका धव इति रुद्र इति पशूनां पतिरग्निरिति ॥ १६ ॥ तस्येतराणि सर्वाण्यशान्तानि नामान्यग्निरित्येवास्य शान्ततमं ... ॥ १७ ॥

श. ब्रा. (काण्व) २-७-१-१-७

TRANSLATION AND NOTES

By sacrifice, indeed, did the Gods ascend to the Heavens (1). Now, this God who lords over the cattle, was left behind here[10] (2). Hence they call him '*Vāstavya*'[11] for it was left behind on the *Vāstu* (3). The Gods went on worshipping and toiling[12] with that very (means) by means of which they ascended to the Heavens[13] (4)... Then, this God who lords over the cattle and who was left behind here,[10] reflected, "I have been left behind. They, verily, exclude me from the sacrifice"(5).

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10 '*iha*' refers either to this world or to the yajña— *vāstu* as Sāyana takes it.

11 "*ata eva vāstau eva sthitatvāt rudro vāstavya iti vedavidaḥ kathayanti*"—Sāyana. The term *vāstu* is used by the Brāhmana in two senses—(*i*) the sacrificial site; (*ii*) that which remains behind, the remnant (of the sacrifice). See section 14. The God *Vāstavya* was left behind on the sacrificial site or he was left behind in or with the remnant of the sacrifice, if we take the word '*Vāstu*' in the second sense of the word. Both the senses seem to be intended by the author of the Brāhmana.

12 This is a form of *tapas* or penance which was regarded as a moral virtue in this age. We come across many legends and passages in the Brāhmanas wherein this virtue is extolled. '*Tapas*,' in the Brāhmanas, takes the form of patient and devout labour, worship, fasting, restraint of speech, etc. 'No pains, no gains' was an article of faith with the moralists of this period. Even great sacrificial deities like Prajāpati, Agni, etc., had to perform *tapas* to gain their object in view.

13 It appears from this that the Gods continued their sacred activities even after reaching the world beyond. They did so because they attached great importance to the *yajña*.

He followed (the Gods) and with his raised (weapon or body)[14] he rose in the north and (when he did this) it was the time to offer the *Sviṣṭakṛt*[15] offering (6). The Gods shouted out to him, "Do not hurl" (7). (Rudra said to the Gods), "Then, do you not exclude me from the sacrifice ; prepare an offering for me[16] (8). (The Gods said), "Be it so" (9). He withdrew ; he did not hurl, nor did he anybody harm" (10). The Gods said (to one another), "Whatever oblations of ours have been taken out (by us)—all those have been offered (by us into the fire). Now devise a means whereby we can prepare an offering for him (*i.e.*, Rudra). (11). They addressed the Adhvaryu, "Sprinkle (with butter) the oblations in due order : then replenish (them all) for an (additional) cutting : make them fresh and then cut off each of the portions" (12). The Adhvaryu sprinkled (with butter) offerings in due order, replenished them for an (additional) cutting, rendered them fresh and then cut off each of the portions (13). Hence they call (him, *i.e.*, Rudra) *Vāstavya*[11] for (what remains) after the oblations have been offered is, indeed, the *vāstu* (the remnant) of the sacrifice. Hence, whenever an offering is ladled up for whatever Deity, the *Sviṣṭakṛt*[15] is everywhere offered a share thereafter for the Gods offered him a share everywhere after (the offering was made) to the Deity (14). That (offering) is, verily, offered to Agni (15), for Agni, indeed, is that God:[17] These, indeed are His names—'*Śarva*'[18] as the Easterners call him, '*Bhava*'[18] the Bāhīkas, *Paśūnām pati*, 'Rudra',[19] Agni, etc. (16). The other (names) of his are inauspicious names : Agni, alone, is the most auspicious name. Hence (the offering) is offered to Agni and (there too to Agni) *Sviṣṭakṛt*[15] (17).

SBR (Madhyan) I-vii-3-1-8

14 '*āyatayā*' is obviously an adjective and hence requires the corresponding form of a noun to make the sense intelligible. The difficulty seems to have been noticed by J. Muir (Original Sanskrit Texts, Vol. IV, Foot-note, 2, p. 202, 1873). He probably felt it to be insurmountable, as he has left the word untranslated. Eggeling (Translation, SBE, Vol. XII, Part I, Foot-note 2, p. 200, 1882) suggests that some such noun as '*heti*' (weapon) or '*tanu*' will have to be supplied to make the sense clear. For the association of '*heti*' with Rudra he quotes SBR, XII-vii-3-20, and observes that in later times this word is specially applied to Agni's weapon or flame. In RV. '*heti*' is a weapon of Rudra (II-33-14) as also of Agni (X-142-3). In view of sections 7 and 10 I am inclined to accept his first suggestion. This is also favoured by the words 'mā' stha (section 7) of both the recensions of the legend. Sāyana offers no help here. He supplies '*Yajñam*' after '*mā visrākṣīḥ*' (section 7) and *samabṛhat* (section 10).

15 For the derivation of this term see Foot-note 8 above.

16 This is said in a spirit of 'give and take' which permeates throughout the Brāhmaṇa Literature.

17 *sa devaḥ* refers to Rudra of the legend.

18 *Śarva* means 'the destroyer.' The term '*Bhava*' is variously explained by Weber, Indische Studien, II, p. 37. According to him it means either the '*Existent*'—'*Eternal*' (*bhavati eva na kadācid na bhavati*) or the 'producer of everything,' (*bhavati asmin sarvam*). *Bhava*, thus, is exactly the opposite of *śarva*. It is a milder name devised with a view to please the terrible God. Here we notice the origin of the later conception of Śiva. See remarks *ante*. For '*Śarva*' and '*Bhava*' the Kāṇva Version has '*Sarva*' and '*Dhava*' respectively.

19 The same God was known as *Paśūnām pati* and *Rudra* amongst other tribes ; for Rudra being the Lord of the cattle, *cf.* SBR, I-vii-4-3. Agni was known as *Paśūnām pati* probably because it was he who helped the Gods to find out their cattle when they were lost.

The legend states the purpose of offering an oblation to Agni *Sviṣṭakṛt* whenever an oblation is offered to a deity. It appears to me to be a legend of worldly wisdom. For this see observations *ante*. For the present I am unable to notice any more versions of the legend.

THE AUTHORSHIP OF THE RĀMĀYAṆA[1]

By

PROFESSOR N. J. SHENDE, M.A., PH.D.,

Nowrosjee Wadia College, Poona

1. VĀLMĪKI is the author of the Rāmāyaṇa, according to the epic itself (1, 4, 2). However, the opinion of scholars like Jacobi, Winternitz, Macdonell and others is rightly inclined to regard the books 1 and 7 of the epic as later additions to the original group of the books 2 to 6, which according to them formed the Rāmāyaṇa of Vālmīki.[2] There are a number of contradictions in the earlier and later portions of the epic. The language and style of the later books is far inferior to that of the earlier books. In the earlier books Rāma appears to be a mortal hero, while in the later books he is depicted as an incarnation of Viṣṇu. In the books, one and seven, there are in the manner of the Mahābhārata various Brahmanical legends and narratives, which are nearly two-thirds of the total number of such legends occurring in the whole of the epic. The period of the composition of the Rāmāyaṇa falls within the interval which separated the Bhārata (Caturviṁśatisāhasrī saṁhitā) and the Mahābhārata (the Śataśāhasrī saṁhitā).[3] In that very same period, the Bhārata came under the very powerful influence of the Bhṛgvaṅgirases, who were responsible for transforming it into the Mahābhārata of a lakh of verses.[4] The Bhṛgvaṅgirases were sages of great antiquity and were directly connected with the institution of sacrifice and magic. They raised the Atharva Veda to the dignity of the fourth veda (along with the Ṛgveda, Yajurveda and Sāmaveda), which was denied to it so long, and made "the saga of the Bharatas" occupy the elevated position of the fifth veda, in its enlarged form, namely the Mahābhārata. The aim of the present paper is to examine the Bhṛgvaṅgiras element in the Rāmāyaṇa and to see how far it helps toward the solution of the problem of the final redaction of the Rāmāyaṇa.

2. The Aṅgirases in the Rāmāyaṇa :—

(1) The name *Aṅgiras* is found with Bhṛgu in the compound Bhṛgvaṅgiras at 2, 32 ,33 and 7, 59 (2) 31. Both Aṅgiras and Bhṛgu were present at the sacrifice performed by King Nimi (7. 55. 9). The Atharvaṇic spells were used in a sacrifice (putrīya-iṣṭi) to get a son. Vasiṣṭha, the Purohita of Daśaratha, with the help of Ṛṣyaśṛṅga performed a Horse-Sacrifice (1.14). Then Ṛṣyaśṛṅga thought of 'putrīya iṣṭi,' a sacrifice to secure

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[1] I am highly indebted to my *Guru*, Professor H. D. Velankar, who guided me in my study of the epics.

[2] See Jacobi : Das Rāmāyaṇa, Winternitz : A history of Indian Literature, page 496.

[3] Dr. Sukthankar : A Volume of Eastern and Indian Studies, page 302.

[4] See my paper in the Annals of the Bhandarkar Oriental Research Institute, Poona, May 1943.

a son and performed it with the spells from the Atharva Veda[5] (1.15.2). Gods, sages and Gandharvas gathered in the chamber of sacrifice (of course invisibly) to receive the oblations offered in the sacrifice. All deities lodged a complaint with Brahmā, the creator of the worlds, that Rāvaṇa had become very powerful, and was oppressing the three worlds and prayed that some means for his destruction should be sought. In the meanwhile Viṣṇu came there. All gods requested Viṣṇu to be born as a mortal in the world and to kill Rāvaṇa. Viṣṇu agreed to this and decided to be born as Rāma, a son to Daśaratha. Just at the time, from the blazing fire of the sacrifice offered by Daśaratha, a huge mysterious being came forth with a golden jar which contained divine drink. He gave it to Daśaratha, who gave it to be drunk to his wives. Thus four sons were born to him due to this Atharvaṇic rite. It is to be noted that the incarnation of Viṣṇu as Rāma, the hero of the Rāmāyaṇa was facilitated by the Atharvaṇic charms (1.16.17). The influence of the Atharva Veda is also seen in the practice of archery (dhanurveda) and mastery over various magical missiles by Rāma. (2) *Gārgya* is mentioned to be a son of Aṅgiras. He was the purohita of king Yudhājit Kekaya, who was the maternal uncle of Bharata. After the coronation of Rāma, Yudhājit Kekaya sent Gārgya to Rāma to secure his help to fight against the armed Gandharvas, who ruled the region on the both sides of the river Sindhu (7.100). (3) Bṛhaspati Aṅgiras is considered to be the standard of intelligence (2.1.32). Bṛhaspati was born as Tāra, a chief of the vānaras when Viṣṇu was born as Rāma (1.17.11) (4) Bharadvāja[6] is often mentioned in the Rāmāyaṇa. He seems to be a pupil of Vālmīki. He was present when the sage Vālmīki uttered the Śloka at the sight of the Krauñca bird, fatally hit by an arrow of the hunter.[7] His hermitage was at Prayāga, on the confluence of the rivers Gaṅgā and Yamunā. Rāma, Lakṣamaṇa and Sītā came to his hermitage on their way to the forest. Bharadvāja requested them to stay in his hermitage during their period of exile. But they refused the proposal, his hermitage being too near to the citizens, who would often come to see them. He then told them the way to Citrakūṭa (2.54). Later on Bharata came to the hermitage of Bharadvāja[8] to search for Rāma. The sage told him the place where Rāma was staying. Here the sage, by means of his miraculous power served the army of Bharata with food (2.91). Bharadvāja with other sages came to the court of Rāma to congratulate him on his coronation (7.1.6). While narrating the account of Kubera to Rāma, Agastya points out that Bharadvāja's daughter by name Devavarṇinī was given in marriage to Viśravas, a son of Pulastya. Kubera was their son. Being pleased with the severe penance, which Kubera practised, Brahmā made him a Lokapāla along with others such as Yama, Indra and Varuṇa. He was also given the Puṣpaka Vimāna. He was a

[5] The Atharva Veda is the Veda of Atharvan. Atharvan is a descendant of Aṅgiras. Hence the Veda is also called Atharvāṅgiras. At Praśna Upaniṣad 2.8, Atharvan is described to be the chief of the Aṅgirases. Bhṛgus are mentioned to be the eyes of Aṅgirases and Atharvans at Gopatha Brāhmaṇa 1. 2. 22. This speaks of their close relation. Hence the Atharva Veda is also called Bhṛgvaṅgiras Veda.

[6] Bharadvājas are the Aṅgirases. See RV. VI. 35. 5.

[7] *Cf.* Rāmāyaṇa I, 2, 15.

[8] *Cf.* Rāmāyaṇa 2. 89. 23. He is mentioned to be the son of Bṛhaspati Aṅgiras, the priest of gods.

step-brother of Rāvaṇa (7.3). (5) Ahalyā was the most beautiful of all women created by Prajāpati. She was the wife of Gautama.[9] Once Indra violated her chastity. Gautama knowing this, cursed Indra that he would not enjoy lordship over gods permanently and Ahalyā that she, deprived of her beauty, would stay near the hermitage and that Rāma, who would be an incarnation of Viṣṇu would free her from the curse and unite her with him (7.30-45). Gautama, the husband of Ahalyā, acted as a purohita at the sacrifice of Nimi (7.55-57). His wife, Ahalyā, was united with him when she was freed of her curse by the favour of Rāma (1.48 15 31). Union of Gautama and Ahalyā was in the same manner as that of Reṇukā and Jamadgni Bhārgava (1.51.11). Śatānanda was a son of Gautama and Ahalyā. He was a purohita of king Janaka. The exploits of Viśvāmitra were narrated by Śatānanda to Rāma (1.51-865). (6) Agastya, after narrating the account of Rāvaṇa to Rāma, points out that Rāvaṇa having secured a boon from Śiva by his penance, came to the snowy mountain. There he saw a beautiful maiden clad in black antelope skin, practising penance. Attracted by her beauty, Rāvaṇa approached her and asked her the purpose of such severe penance in the prime of her youth. She treated him, however, as a respectable guest and told him that her father was a great sage by name Kuśadhvaja, the son of Bṛhaspati Āṅgirasa. Her name was Vedavatī. Her father intended that she should be given in marriage to Viṣṇu, the lord of the three worlds. A certain king of the demons by name Śaṁbhu was refused her hand in marriage on this account, by her father, and hence her father was killed by the demon king when he was enjoying sleep. Her mother consigned herself to fire with her deceased father. Vedavatī with the sole object of securing Nārāyaṇa as her husband was practising penance. Naturally she refused all advances made by the passionate Rāvaṇa. He asked her to be his wife. She refused his proposal. Rāvaṇa then attempted to touch her hair on the head. She was burning with anger at this outrage and cut off her hair with her hand, which had assumed the form of a sword. Being a woman, she did not like to kill him. She felt that there was no purpose in her life as she was outraged by Rāvaṇa. Hence she decided to consign herself to flames. Before burning herself she cursed Rāvaṇa that she would be born again to kill him. She was born as Sītā, the daughter of king Janaka. He found her while he was ploughing the earth for the purpose of preparing a sacrificial altar. Thus Vedavatī a grand-daughter of Bṛhaspati Āṅgirasa was born as Sītā, was married to Rāma, an incarnation of Viṣṇu, and thus she realised her desire of killing Rāvaṇa (7.17). (7) Then Rāvaṇa came to the sacrifice of king Marutta. Saṁvarta, a brother of Bṛhaspati Āṅgirasa was his purohita. Seeing Rāvaṇa in the sacrifice, all gods including Indra, Varuṇa and Kubera assumed the forms of different lower creatures. Rāvaṇa asked Marutta for a fight with him or to be declared a victor. Marutta thought himself to be powerful enough to kill Rāvaṇa. But Saṁvarta told him not do anything which would violate his vow as a sacrificer. For he was performing Maheśvara Satra and any break in it would mean the destruction of his whole family. Thus Marutta refrained from the violation of his vow only at the opportune advice of Saṁvarta and saved his family from destruction (7.18). (8) A sage by

9 Bhavabhuti in Mahāvira carita I, refers to the story of Gautama and Ahalyā, and further points out that the family of Śatānanda, their son, was Āṅgirasa.

name Gārgya Trijaṭa once came to Rāma to ask for some help. He is mentioned to have lustre like that of Bhṛgvaṇgiras (2.32.33).

3. The Bhṛgus in the Rāmāyaṇa :—

(1) The name Bhṛgu, occurring also in the compound Bhṛgvaṇgiras, figures independently in the story of king Nimi. King Nimi had become bodiless on account of a curse of the sage Vasiṣṭha. He was revived by Bhṛgu. The king had no issue. His body was churned and a son was produced from it. This was Janaka, who was also called Vaideha. Thus Janaka's father was revived by Bhṛgu (7.57). In a fight between the gods and the demons, the latter resorted to Bhṛgu's wife, who promised shelter to them. Viṣṇu,[10] knowing this, cut off the head of the wife of Bhṛgu with his discus. Bhṛgu became enraged at this and cursed Viṣṇu to be born in the mortal world and to suffer separation from his wife for a long time. It was on account of this curse of Bhṛgu that Viṣṇu became ready to be born as Rāma on the earth (7.51). His actual birth was effected by the charm from the Atharva Veda, as said above. (2) Asita, a king of the family of Ikṣvāku, with his two wives, stayed on the snowy mountain. Both of his wives were pregnant. One of them Kālindī was poisoned by her co-wife. She came to the sage Cyavana,[11] who stayed on the snowy mountain. Cyavana blessed her that an illustrious son would be born to her. This son was Sagara after whom the ocean is called Sāgara (1.70 and 2.110). Cyavana narrated to Śatrughna the prowess of the mighty demons Lavaṇa and Śūla and told him the means of killing them (7.67). (3) Uśanas Bhārgava officiated in the seven sacrifices such as Agniṣṭoma, Aśvamedha, Rājasśya, Maheśvara and others performed by Meghanāda, a son of Rāvaṇa. Meghanāda secured from these sacrifices a wonderful magic chariot moving in air, magic power called Tāmasī Māya, a quiver containing inexhaustible arrows and a number of magical missiles. Rāvaṇa came to this sacrifice and threatened his son for worshipping gods, who were his enemies. However, he was pleased to learn from Uśanas the importance of his son's achievements (7.25). Uśanas cursed Yayāti, his son-in-law, to be old ; for Yayāti had almost deserted Devayānī and disregarded her son Yadu (7.58). Daṇḍa, the youngest of the hundred sons of Ikṣvāku, ruled the country between Vindhya and Śaivala mountains. Uśanas Bhārgava was his purohita. Once Daṇḍa came to the hermitage of Uśanas in the month of Caitra. The sage was not there. On seeing his beautiful daughter, Arajā, the king fell desperately in love with her. In spite of her protests, he forced his will on her and went away. Later on Uśanas came to know of this incident. He became wild with anger and cursed that the whole kingdom would be completely destroyed before the end of a week. Indra at his bidding showered dust on the kingdom of Daṇḍa. The whole region later on became a forest and came to be known as the Daṇḍakāraṇya. Before this destruction Uśanas asked the inmates of his hermitage to go beyond the territory of Daṇḍa. There a number of ascetics and Arajā stayed near a beautiful lake. This settlement was called Janasthāna (7.79-81).

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10 At Rāmāyaṇa 1. 25. 21 the wife of Bhṛgu was killed by Viṣṇu for she desired a world where there would be no Indra.

11 He was a Bhārgava and sometimes styled as Āṇgirasa. *Cf.* Śatapatha Brāhmaṇa 4. 1. 5. 1. This speaks of the Unity of the families of Aṇgiras and Bhṛgu. At Rāmāyana I. 38 the same account occurs, where Bhṛgu is mentioned instead of Uśanas and Keśinī for Kālindī.

(4) Aṁbariṣa, a king of Ayodhyā, performed a sacrifice when the victim in it was taken away by Indra. Some human substitute was required. The king, while in search of a human victim, came to Ṛcīka on Bhṛgutuṅga. Ṛcīka had three sons and was willing to sell his middle son Śunaḥśepa for one thousand cows. Śunaḥśepa then happened to see his maternal uncle Viśvāmitra. He praised Viśvāmitra, who promised to rescue him. He taught him two divine verses (Gāthās) to be recited when he would be tied to the sacrificial post to be killed. Wrapped in a red garment, he was then taken to the sacrificial post and was tied there. There he recited the two verses. The gods Indra and Viṣṇu were highly pleased with him and blessed him with long life (1.61-62). (5) While returning from his marriage, Rāma met Paraśurāma. Daśaratha was afraid of him. Meeting face to face, Paraśurāma told Rāma that he should string the bow, which Viṣṇu himself had given to his grand-father and become ready for fighting. Rāma took the bow with arrow from him and told him that as he was a Brāhmaṇa and a nephew of Viśvāmitra, he would not kill him. For, the arrow of Viṣṇu would never be futile. He further told him that the arrow when discharged would block his courses either on the earth or to the other worlds. Paraśurāma felt that Rāma really possessed lustre superior to himself and allowed him to block his course to the other worlds. Perhaps Paraśurāma felt that he himself was a partial incarnation of Viṣṇu; while Rāma was a complete incarnation of the Lord. Thus the divinity of Rāma was established beyond doubt (1.74-76). (6) Viśvāmitra[12] was a relation of the Bhṛgus. His elder sister Satyavatī was given in marriage to Ṛcīka, a Bhārgava.

4. Taking a review of the brief account of the Bhṛgvaṅgiras element in the Rāmāyaṇa, it may be noted that the Bhṛgvaṅgirases play a very interesting part in it. The close relation between the Bhṛgus and Aṅgirases is indicated by the name Bhṛgvaṅgiras[13] occurring in the Rāmāyaṇa itself. The charms from the Atharva Veda were responsible for the birth of Rāma, the hero of the epic. Bharadvāja Āṅgirasa was pupil of Vālmīki and possessed miraculous powers. His daughter Devavarṇinī gave birth to Kubera, the step-brother of Rāvaṇa. Gautama acted as a purohita in the sacrifice of Nimi. His wife Ahalyā was freed from his curse by Rāma. This paved the way for the exaltation of Rāma as a divine being. Bṛhaspati was considered to be a standard of high intelligence. His grand-daughter, Vedavatī, was born as Sītā, for the destruction of Rāvaṇa. Saṁvarta Āṅgirasa acted as a purohita in the sacrifice, offered by king Marutta. Bhṛgu revived Nimi, the father of Janaka. It was on account of his curse that Viṣṇu was required to be born as Rāma. The birth of Sāgara was due to the blessings conferred on his mother by Cyavana. Uśanas was a purohita of king Daṇḍa. On account of his curse, the kingdom of Daṇḍa was turned into the Daṇḍakāraṇya forest. The territory beyond his kingdom was named as Janasthāna. Both these places are fairly associated with the life of Rāma. The defeat of Paraśurāma by Rāma actually

[12] In the Mahābhārata, his birth and his conversion to Brāhmaṇahood is explained as due to the influence of Bhṛgu. See Mbh. 2. 115-117.

[13] For the relation between the Bhṛgus and Aṅgirases, see my paper in A.B.O.R.I. The compound name Bhṛgvaṅgiras like Atharvāṅrgias, is in singular. It may be that the priestly clans of the Bhṛgus and the Atharvans are the descendents of one ancient family of Aṅgiras.

established the fame of Rāma as an incarnation of Viṣṇu. Thus we can easily see that Rāma, Sītā, Janaka, Kubera, Rāvaṇa, Daṇḍakāraṇya and Janasthāna which figure very prominently in the Rāmāyaṇa are all mentioned in the epic as due to the Bhāgvaṅgirases. Viśvāmitra, a relation of the Bhṛgus, plays a leading role in the 1st book of the epic. In nearly 45 out of 77 chapters of the 1st book, Viśvāmitra narrates various legends to Rāma. In about 15 more sections (51-65) Śatānanda Āṅgirasa narrates the greatness of Viśvāmitra to Rāma and others. In the 7th book Agastya narrates the legends to Rāma and others in more than forty chapters. Agastya is the brother of Vasiṣṭha, the purohita of the Ikṣvākus. This explains the presence of Agastya-element in the epic. It cannot be a mere chance that Bhṛgvaṅgiras element is strikingly present in the admittedly later portion (1st and 7th books) of the epic. The legends and narratives stitched round the Bhṛgvaṇgirases are vitally connected with the most prominent personalities in the epic. It must be a definite attempt to deify and elevate Rāma and thus to make him a fullfledged incarnation of Viṣṇu. It is thus, very probable that the Bhṛgvaṅgirases influenced directly or indirectly the enlargement of the epic. They kept Vālmīki as the author, as this device at once gave the same popularity and honour as the original composition of Vālmīki. They also introduced Kuśa and Lava, the pupils of Vālmīki, as the singers of this Ādikāvya, to give authenticity to the enlarged work. Vālmīki with Kuśa and Lava, the sons of Rāma, came to the Aśvamedha sacrifice, offered by Rāma, and the whole epic of 24000 verses and 100 upākhyānas was sung by them there.[14] It is interesting to note here that out of these 100 upākhyānas, more than 60 occur in the later portion of the epic (1st and 7th books). The remaining upākhyānas are spread over the older books of the epic. Nearly 20 of these are found in the 3rd book.

The Bhṛgvaṅgirases, who were the leaders of society and who championed the cause of the Bhrāhmaṇas and the orthodox Vedic religion, must have attempted to infuse a new spirit in the old Vedic religion, to remedy the growing indifference of the general public towards the Vedic religion in particular[15] and to stem the tide of the heterodox religions like the Buddhism and the Jainism[16] by transforming the Bhārata into the Mahābhārata and the Rāmāyaṇa of Vālmīki (2nd to 6th books) into the present epic of seven books. In this respect, these redactors have achieved wonderful success, as can be seen from the matchless popularity these two epics have enjoyed and the influence they have exercised on the minds of the people in general, for the last two thousand years.

The Rāmāyaṇa of Vālmīki and the Bhārata of Vyāsa may have been the independent products belonging to eastern and western parts of India respectively. When the Bhṛgvaṅgirases attempted to transform the Bhārata into the Mahābhārata, they must have also handled the Rāmāyaṇa of Vālmīki and absorbed it in the Mahābhārata in the form of its condensed summary (the Rāmopākhyāna).[17]

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14 *Cf.* 7. 94. 24-25.

15 Mbh. 18. 5. 62-63.

16 At 2. 109. 34 Rāmāyaṇa refers to Buddha. This reference is considered to be a later addition.

17 See Winternitz : A History of Indian Literature, page 501 and 507 ; and Dr. Sukthankar : A Volume of Indian Studies, page 303.

THE RĀMĀYAṆA IN THE LIGHT OF ARISTOTLE'S POETICS[1]

By

PROFESSOR R. SADASIVA AIYAR, M.A.,

D. A. V. College, Sholapur

I. THE TITLE OF THIS ESSAY

THE title of this essay needs some clarification. I do not propose to start with some of Aristotle's canons and apply them *a priori* to the Indian epic. That would be just the way to misinterpret the epic and misapply the canons. The right method of appreciating a poem is to begin by studying the central situation or conflict, to proceed therefrom to an understanding of it in relation to character, to perceive the bearing of scenes, dialogues and setting on the *motif*, to grasp the philosophy that underlies and suffuses them, to pass on from these to the technique of diction and style ; and crown it all by tracing in it the profile of the age and the writer. In the course of our study we may recall some critic and find the work under review illustrating some of his general principles. We do not begin, then, with Aristotle, but with the *Rāmāyaṇa*, meeting the Stagirite only *en route*. But even in this it is worth while remembering that the *Rāmāyaṇa* embodies an ethos and *Weltanschauung* different from those which underlie Greek literature. We can study here only a few aspects of the first six books of the epic, which are bound by an organic unity that does not extend to the last book—the *Uttara Kāṇḍa*, which is the afterthought of another poet.

II. THE GENERAL CHARACTER OF THE RĀMĀYAṆA

Before we glance at specific features in the epic that recall the *Poetics* it would be well to have a clear idea of its general character. As a work of art, the *Rāmāyaṇa* spreads its wings over two distinct domains of literature—the realistic and the romantic. The characters are now human, now superhuman, now both. Some characters, like Vāli and Hanumān, blend these with the sub-human, and do so without a jarring note or hint of incongruity.

Hanumān is at one moment a typical monkey, at another a man, and at a third a god. Mistaking Mandodarī (in Rāvaṇa's harem) for Sītā, and seized by an uncontrollable joy, he lustily smacks his arm, kisses his tail, jubilates and dances, sings in wild glee and paces the hall, swarms

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1 The references to *The Rāmāyaṇa* are all to the edition by T. R. Krishnacharya. In this article I have received considerable light and guidance on many points from the Rt. Hon'ble V. S. Srinivasa Sastri and Mr. R. Narayan Aiyar, I.C.S. (Retd.), of Madras—both great students of *The Rāmāyaṇa*.

up pillars and leaps down—exhibiting in diverse ways his simian nature.[1] In another context he is intensely human. Having set fire to Laṅkā and wrought incalculable destruction on men and mansions, he lashes himself for his rash and precipitate conduct, thinking that in his spasm of wrath he has reduced to ashes Sītā herself: "I have frustrated the very object for which I launched on this enterprise. . . . If through my perverse intelligence I have wrecked my venture I think I cannot do better than put a quietus to my life here."[2]

And he dilates on the chain of consequences that are sure to follow from unreflecting passion. Earlier in the story, when he is first introduced to us and to the hero, he is the beau ideal of a scholar gifted with a sovereign mastery of classically finished and euphonious speech ; the perfect elocutionist, whose immaculate diction, exquisite modulation of voice and felicity of presentation hold the listener in a spell and beget despair in crude performers.

नानृग्वेदविनीतस्य नायजुर्वेदधारिणः ।
नासामवेदविदुषः शक्यमेवं प्रभाषितुम् ॥
नूनं व्याकरणं कृत्स्नमेतेन बहुधा श्रुतम् ।
बहुव्याहरताऽनेन न किंचिदपशब्दितम् ॥
न मुखे नेत्रयोर्वाऽपि ललाटे च भ्रुवोस्तथा ।
अन्येष्वपि च गात्रेषु दोषः संविदितः क्वचित् ॥
अविस्तरमसंदिग्धमविलम्बितमद्रुतम् ।
उरस्थं कण्ठगं वाक्यं वर्तते मध्यमे स्वरे ॥
संस्कारक्रमसंपन्नामद्रुतामविलम्बिताम् ।
उच्चारयति कल्याणीं वाचं हृदयहारिणीम् ॥
अनया चित्रया वाचा त्रिस्थानव्यञ्जनस्थया ।
कस्य नाराध्यते चित्तमुद्यतासेररेरपि ॥

Kiṣkindhā, iii, 29-34.

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1 *Sundara Kāṇda :* Sarga X,55—

आस्फोटयामास चुचुम्ब पुच्छं ननन्द चिक्रीड जगौ जगाम ।
स्तम्भानरोहन्निपपात भूमौ निदर्शयन्स्वां प्रकृतिं कपीनाम् ॥

2 *Sundara :* Sarga LV—

यदर्थमयमारम्भस्तत्कार्यमवसादितम् ।
मयाहि दहता लङ्कां न सीता परिरक्षिता ॥ 10
ईषत्कार्यमिदं कार्यं कृतमासीन्न संशयः ।
तस्य क्रोधाभिभूतेन मया मूलक्षयः कृतः ॥ 11
यदि तद्विहतं कार्यं मया प्रज्ञाविपर्ययात् ।
इहैव प्राणसंन्यासो ममापि ह्यद्य रोचते ॥ 12

But elsewhere, with his supernatural powers in full manifestation, he is the embodiment of the sublime. He ploughs the sky, as doth a mighty ship the ocean. As he careers he seems to devour the firmament itself, clawing his way through the moon, hauling behind him as it were the very star-spangled heavens :

वातसंघातजातोर्मिचन्द्रांशुशिशिराम्बुमत् ।
हनुमान्मारुतगतिर्महानौरिव सागरम् ॥
अपारमपरिश्रान्तः पुप्लुवे गगनार्णवम् ॥
ग्रसमान इवाकाशं ताराधिपमिवोल्लिखन् ।
हरन्निव सनक्षत्रं गगनं सार्कमण्डलम् ॥

Sundara : Sarga lvii, 3-5.

Hanumān's flight across the sky invites comparison and contrast with Satan's through Chaos. Morally and spiritually they are poles apart. The one invades the kingdom of Evil (Laṅkā) to emancipate the imprisoned Light of Good (Sītā) ; the other sneaks into Paradise to usurp the realm of God and gain sway over His children. But in the conception of these figures there is a similarity, in that they show a harmonious fusion of human, sub-human and superhuman elements. In Satan what is sub-human is diabolic ; in Hanumān it appears only as an element of the comic. What is true of Hanumān is true also of Rāma, Rāvaṇa, Lakṣmaṇa, Vāli, Viśvāmitra, Mārīca and others of his race endowed with supernatural powers.

As with the characters, so with the incidents. Some of these are realistic, others supernatural. We have examples of this crossing of two planes in *The Tempest*, in Barrie's *Mary Rose*, in Ibsen's *Peer Gynt*, in Goethe's *Faust*, the *Divina Commedia*, the *Iliad*, the *Aeneid* and similar works of art. But in studying the technique of the plot of the *Rāmāyaṇa* we need not bother much with the supernatural elements, for it is a web woven by characters whose greatness and weakness—considered from the standpoint of plot—are human. What is preter-human can be disengaged and set aside when we study the epic as an *imitation of* life, as *mimesis* in the *Aristotelian* sense.

But it is important for our purpose to realize that this poem which has a human foreground—mingled indeed with supernatural colours—has a cosmic background. The exile of Rāma, the abduction of Sītā, the solemn pact with an ally whose plight is similar to the hero's own; the tribulation of Sītā, the preliminary reconnaissance of the enemy's capital and resources by Hanumān in his dual role of spy and ambassador, the stupendous preparation and battle with Rāvaṇa, the victory, the retrieving of the lost wife, and the fulfilment of the fourteen years' ordeal for Truth and Dharma, are the main elements of the human foreground. The redemption of the world from an all-powerful oppressor whom even the gods dreaded and the symbolic triumph of the Divine in History provide the cosmic background.[1] It is to achieve this Great End that Brahmā and the gods implore Viṣṇu to incarnate himself in

1 If we take the first six books together.

the world of men. This, indeed, is *Rāmakārya*—the burden of the *Rāmāyaṇa.* The worlds rejoice on Rāvaṇa's death. It is for the accomplishment of this End—the destruction of Evil—that Sītā was created;—created with such entrancing loveliness that she might be the unconscious instrument of Rāvaṇa's doom :

जनकस्य कुले जाता देवमायेव निर्मिता ॥[1]

She is the enchanting lure devised by Brahmā to compass the ruin of that Terror of mankind—for *Rākṣasa Māyā* can only be foiled by *Dēva Māyā.* The purpose of this background of Divine Will is to make the reader conscious of a world of the Spirit in which the forces of Good are for ever working with eternal vigilance. We are, metaphysically, in a realm of certitude—the poet being a sage and a mystic to whom God is not a problem but felt experience. He is at the very antipodes of the author of *The Dynasts*, with its Spirit of the years, the Pities, the Ironies and the Immanent Will. But the Poet's philosophy does in no way interfere with our interest in the story. *Therein*, to use Meredith's words, "the passions spin the plot." This epic is untouched by the contention that a story in which events occur by a fatality, as the result of Divine preordination, would be devoid of all human significance.

III. The Unity of Action and Leitmotif

There is between character and action a close nexus throughout—except in a few discordant places that militate against the rest of the epic as a whole. The pivotal event is the destruction of Rāvaṇa, and all happenings—except the episodes which are mostly in the *Bāla Kāṇḍa*—bear upon that *dénouement.* But the fact that they do so becomes clear to the reader only when, at the close of the poem, he views in retrospect the paths he has traversed. It is then that he realizes why, early in the poem, while the hero was but a boy of twelve, his help was besought by Viśvāmitra, for the sacrifice. In the *Bāla Kāṇḍa*, it has the deceptive look of an episodic adventure, and one hardly realizes that it is the seed-ground from which future events sprout and proliferate like the Daṇḍaka forest itself. Mark how it prepares us for what is for us, at this stage, an unforeseen end. It is to Viśvāmitra that Rāma and Lakṣmaṇa owe their acquisition of, and initiation into, the use of divine weapons, which are to stand them in such good stead later, in many a crisis. We meet Tāṭaka, the mother of Mārīca himself, who figures later at the fulcrum of the story.[2] By an irony of chance—like the loss of Desdemona's handkerchief—Rāma's arrows, forgetting their lethal power, succeed only in driving him off a hundred *Yojanas* and striking him down all of a heap on a remote strand. The poet knows that Mārīca must live to recount his story to his overlord—to what paradoxical end we shall see later. Even more momentous for the future is the wedding of Rāma and Sītā, pointing a finger to a human tragedy and a divine comedy. In tearing the princes off from the bosom of their doting father, Viśvāmitra unconsciously sets in motion the hidden springs that unwind the

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1 *Bāla Kāṇḍa :* i, 25.

2 C. V. Vaidya misses its essential character when he says, "The story of the golden deer is a later addition." *The Riddle of the Rāmāyaṇa*, p. 145 ; *vide infra* the section on the *Hamartia.*

plot. Herein we have (in the *Bāla Kāṇḍa*) what roughly corresponds to the *protasis* of a play.

The train of events that constitute the protasis prepares the ground and endows it with potentialities whose expression will depend upon the seed that may be sown in it. In other words, it only starts the *external* action. But to state a truism, every work of art has an inner (or moral) as well as an outer (or material) action. In tragedy they assume the form of internal and external conflict. Now, at the beginning of the *Ayōdhya Kāṇḍa*, the *moral* action receives its initial momentum. Old King Daśaratha, summoning a mighty assembly of the great and wise of his state and of its citizens at large, proclaims to them his desire to install Rāma as Crown Prince. With one acclaim they signify their will—which they say is even greater than *his* desire—to behold Rāma, of peerless prowess and power, making his royal progress in procession along the city's promenades, on the lordly elephant of state, with the Great Umbrella encircling his head like a halo ; they long to behold him so, because the king himself has become old,—old with the weight of many thousands of years :

अनेकवर्षसाहस्रो वृद्धस्त्वमसि पार्थिव ।
स रामं युवराजानमभिषिञ्चस्व पार्थिवम् ॥
इच्छामो हि महाबाहुं रघुवीरं महाबलम् ।
गजेन महताऽऽयान्तं रामं छत्रवृताननम् ॥[1]

The scene is pregnant with Sophoclean irony. The citizens' desire will not be fulfilled for many a long year, and in place of the Coronation they will see with tearful eyes the exile of the Prince whose qualities had enthroned him in their hearts. The exile follows inexorably from character. Nothing in the world can shake Rāma from his resolve to see that his father's pledged word is not broken. Nothing is greater in the world than the maintenance of Truth and Dharma. If they fall, the world crumbles to ashes ;

"And there is nothing left remarkable
Beneath the visiting moon."[2]

Neither the piteous pleadings of his mother nor the wrath of Lakṣmaṇa, nor the heart-rending cry of the old king that he should be shelved and put in durance as a dotard,[3] nor the touching supplication of Bharata can move Rāma even by a hair's breadth from the path of righteousness. With a lonely sublimity he stands four-square to the winds of temptation—a sublimity that recalls Jean Valjean's when he turns away at the close of a racked and tortured life from the proffered haven of rest in his darling Cossette's home, because the price of that rest was paltering with conscience : "It is not enough to be happy, we must be satisfied with ourselves."[4] The sophisticated modern reader might be tempted to exclaim:

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1 *Ayōdhyā :* ii, 21-22.

2 *Antony and Cleopatra :* IV—xv, 66-67.

3 *Ayōdhyā :* XXIV, 26.

4 *Les Miserables :* Bk. VII, i.

"Well, this Rāma of yours looks like an embodied abstraction and a monster of perfection—'faultily faultless, icily regular, splendidly null'; he is nothing more than the epic analogue of Sir Charles Grandison." But herein Vālmīki achieves a marvel. Throughout Rāma is alive and real as a human being.[1] He may be the incarnation of Viṣṇu himself, but as a character in the poem a god "in prison lies";[2] not so the man.

Kaikeyi has a sinister magnificence of her own, with a family resemblance to Clytemnestra. But, as an agent in Rāma's destiny, her part, potent as it is, is ancillary to his. Where would she be but for Rāma's masterful "Will to Virtue?"[3] Note the manner in which the Poet hints the filiation of events from first to last. Says Rāma of Kaikēyi's part, absolving her of all blame, and seeing in her the hand of Destiny which works towards unforeseen ends :

कृतान्तस्त्वेव सौमित्रे द्रष्टव्यो मत्प्रवासने ।
राज्यस्य च वितीर्णस्य पुनरेव निवर्तने ॥
कैकेय्याः प्रतिपत्तिर्हि कथं स्यान्मम वेदने ।
यदि तस्या न भावोऽयं कृतान्तविहितो भवेत् ॥[4]

In the *Rāmāyaṇa*, then, the mainspring of the action is the resolve of the hero to stand by the moral law, and as such it stands unique among the epics of the world. The central theme of the poem, the destruction of Iniquitous Power, which is "*Rāma Kārya*," logically connects itself by a series of events with that resolve.

Consider the logic of these events in the *Aranya Kāṇda*. Once he is in the forest, Rāma turns the stumbling-blocks of Chance into the stepping-stones of self-fulfilment as a Kṣatriya prince. Implored by the ascetics, who had been preyed upon in thousands by the Rākṣasās, he constitutes himself their guardian;[5] for always his watchword had been to guarantee protection to those who sought refuge in him :

सकृदेव प्रपन्नाय तवास्मीति च याचते ।
अभयं सर्वभूतेभ्यो ददाम्येतद्व्रतं मम ॥[6]

In order to save the ascetics from the Rākṣasa menace, Rāma chooses a strategic spot in Janasthāna, the region carved out by the cannibals as

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1 Once indeed there is a touch of the prig, as when he advises his mother as to what her duty is to her husband. See *Ayōdhyā :* xxiv, 24 *et. seq.* Apropos of his conduct to Sītā, see close of this section. On the character of Vālmīki's Rāma there is an illuminating article by Mrs. Savitri Pattabhiraman in the June number of the Tamil Monthly, *Kalaimagal* (1943).

2 Contrast Donne : "So must pure lovers' souls descend.
T'affections and to faculties, which sense may reach and apprehend.
Else a great Prince in prison lies."
The Ecstasy.

3 Contrast "The Will to Power."

4 *Ayōdhyā :* xxii, 15-16.

5 *Aranya :* vi.

6 *Yuddha :* xviii, 33.

their special poaching ground and claimed as a province of their own. He is helped to that choice by Agastya :

अपि चात्र वसन्राम तापसान्पालयिष्यसि ॥[1]

If the sages need his protecting arm, he in turn needs their blessing—and tangible boons too. In the final contest, at a critical hour, he would use the sword, the arrow and the bow of wondrous workmanship and power—chased with gold and gems—presented to him by Agastya.[2] Thus the visit to the sages is wrought into the rest of the plot. The scenes of Śūrpaṇakhā, Khara and Dūṣaṇa, Mārīca and Rāvaṇa, the decoy deer, the abduction, the search through Kiṣkindhā, the pact with Sugrīva, the slaying of Vāli and other incidents, follow in an unbreakable chain. The perception of this magistral unity of the poem enables us to single out the cantos and verses that, coming in as later additions, strike at this unity. Of this nature are cantos 115-118 of the *Yuddha Kāṇda*, which stultify half the action of the poem and transmogrify the hero, giving the lie to everything he had said and thought about Sītā before he started in quest of her.[3] Before the launching of the expedition Hanumān had given Rāma a picture of Sītā's self-martyring devotion to him;—a picture calculated to fill even the most exacting and the most self-righteous husband with compassion for his wife : "Her love and devotion for you have made her subject herself to the discipline of the direst penance.[4] Pale, wasted and woe-begone your queen is, and her thoughts have one and only mark and centre—her lord. She was on the point of blotting her life out when I appeared before her providentially.[5] And she has bidden me tell you this in special that she could contrive to cling to life a month more at the most, not a day longer."[6] Seeing Sītā's gem (चूडामणि) Rāma felt as though he had got her very self back :

आसाद्य दर्शनेनाहं प्राप्तां तामिव चिन्तये ।

"Your words, O Hanumān," said Rāma then, with a tide of love surging within him, "revive my swooning heart like life-giving water. Now that I have known her whereabouts, I cannot sustain my life even a moment longer without her. Delay not, but lead me on to where my beloved is."[7] *Now*, this same Rāma, crowned with victory, with the prize of war in his hand, has the heartlessness to tell Sītā, standing before him in a trance of joy and love, but also shrinking with shame and a sinking of spirits : "Let this be known, my lady, it was not love of you that made me accomplish this labour of war ; what prompted me to it was the desire to guard my character and to ward off the stain that the world would else have cast on my house.[8] . . How can I take back one

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1 *Aranya :* xiv, 22.

2 *Aranya :* xii, 30-35 ; and *Yuddha :* cviii, 4.

3 I do not attempt a full discussion of this problem here as it will unduly distend this article.

4 *Sundara :* LXV, 18.

5 LXV, 14 : मर्तव्येति कृतनिश्चया—"She is resolved on death."

6 LXV, 24.

7 *Sundara :* LXVI, 3, 7, 8, 10, 11.

8 *Yuddha :* CXVIII, 15-16.

who is stained by contact with the lap of Rāvaṇa, stained too by being gazed upon by him with lustful eyes ? No longer do I love you. Well, the world is all before you to go wheresoever you like. You are free to turn your love to whomsoever you like—Lakṣmaṇa, Bharata, Sugrīva or Vibhīṣaṇa :[1]

लक्ष्मणे वाथ भरते कुरु बुद्धिं यथासुखं ॥
सुग्रीवे वानरेन्द्रे वा राक्षसेन्द्रेवा विभीषणे ।
निवेशय मनः सीते यथा वा सुखमात्मना ॥"

—words shocking in their callous disingenuousness ! Their ring of egoism and self-righteousness recalls that of Sir Willoughby Patterne when he adjures Clara Middleton to promise him that she would not marry again after his death, should he happen to predecease her.[2] Two revolting expressions of the self-assertive male. In their physical revulsion they recall the attitude of Angel Clare when he drops Tess like an infected thing on learning, from her volunteered confession, of her misfortune in the past.[3] Is it at all likely that the poet who had seen the evolution of his story on the screen of his mind turned his Pegasus into Bully Bottom towards its close ?—that having commenced his poem with the grandeur of the Ganges descending from Kailāsa made it end in a swamp ? Or, if these unlovely patches in the hero's character were deliberately intended by the poet, would he have vitiated his art by springing them on us as a surprise at the close ? No ; these cantos (118-119) bear the stamp of being the additions of a miserable botcher. But, as we have said, interpolated slabs like these can easily be recognised and detached from the structure of the poem. The *Rāmāyaṇa* is bound by a double unity—the unity of action and the unity of a moral idea, which may be stated thus : "Man's *summum bonum* on earth is the upholding of the moral law, whose foundations are truth and compassion." The maintenance of Truth starts the action—the note of humanity closes it. The conquered people of Laṅkā come under the wings of Rāma's loving care and protection like his own people : "जनोऽयं स्वजनो मम" is his solemn injunction to Vibhīṣaṇa ;[4] and more by token, Sītā refuses to allow Hanumān to molest the Rākṣasīs who had for months subjected her to all manner of harassments,—driving home her exhortation with the impressive apologue of the ऋक्षगीत.[5]

In all this there is no question of didacticism. The moral idea flows through this epic like its life-giving sap and envelops it like an atmosphere ; it causes and sustains its movement like its *vis viva*. In this respect the two Indian epics stand unique among the epics of the world. The *leitmotif* in the *Rāmāyaṇa* is not impaired by any conflict in the poet's mind such as we have in the *Divina Commedia* between religious doctrine and inner intuition.

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1 *Yuddha* : 20-23. Govindarāja softens the meaning by interpreting it thus : "Go and stay under the protection of anyone you like—Lakṣmaṇa, etc. "

2 Meredith, *The Egoist*, ch. 6.

3 Hardy, *Tess of the D'Urbervilles.*

4 *Yuddha* : CXVII, 26.

5 *Yuddha*, cxvi, 43 ; *Cf. Yuddha* : XVIII, 24-33, where Rāma enforces the duty of शरणागतरक्षण with the story of "the Pigeon and the Hunter."

Unity of action considered, the *Rāmāyaṇa* stands in sharp contrast to the *Odyssey*,[1] the bulk of which is composed of disconnected incidents : Odysseus pining away eight years in Calypso's island, the wreck on the coast of Phaeacia, the sojourn in the land of the Lotos-Eaters, the adventures in the land of the Cyclops and the cave of Polyphemus, the experiences in Circe's Isle, the descent into Hades, the escape from the Sirens, Scylla and Charybdis, do not evolve as by an inevitable logic.

The unity of the *Rāmāyaṇa* reminds us of Aristotle's dictum : "Of simple plots and actions the episodic are the worst. I call a plot episodic when there is neither probabilty nor necessity in the sequence of its episodes."[2] And again, "The story as an imitation of action must represent one action, a complete whole, with its several incidents so closely connected that the transposal or withdrawal of any one of them will disjoin and dislocate the whole. For that which makes no perceptible difference by its presence or absence is no real part of the whole."[3]

I have dwelt at some length on the Unity of the poem, because it is just this that several scholars have missed. Here is a specimen of hasty criticism from *The Growth of Literature* by the Chadwicks : "The rest of the story contained in Books III-VI can hardly be regarded otherwise than as romance. In principle it resembles the romantic part of the Odyssey, though it is largely concerned with fighting."[4] The shallowness of this view will become clearer if we examine the dynamic of the plot in the scenes that constitute its dramatic crisis. We have it in Sargas 31-46 of the central Book—*The Araṇya Kāṇḍa.*

IV. The Threefold Peripeteia

In Sarga 46 we see that everything has turned out for the dread Emperor of the Rākṣasās better than he had planned. But the sovereign moment was yet to come as he bided his time within hail of the *Parṇaśāla* at Pañchavaṭi. He had heard, as had Sītā and Lakṣmaṇa, the death-cry of Mārīca with its deceptive simulation of Rāma's voice. But Lakṣmaṇa was still at Sītā's side as a danger-signal. It was the zero hour for Rāvaṇa. But, presently, the anxiously awaited moment wooed him as it did the Macbeths when Duncan invited himself to their castle :

तदासाद्य दशग्रीवः क्षिप्रमन्तरमास्थितः[5]

I have said that things fell out better than he had planned ; in what way better ? There was in his *ruse de guerre* a little snag which he failed to foresee and provide for. But the snag, through the strangest good fortune, —and ill fortune ! —disappeared. To understand this we must hark back to Sarga 31 and review the plot therefrom. There Akampana reports to his sovereign the appalling slaughter of fourteen thousand Rākṣasa warriors by Rāma single-handed. Everyone of them felt that he was faced by a separate Rāma.

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1 The authors of *The Growth of Literature* have missed this point.

2 *Poetics :* Ch. 9, E. T. by Butcher.

3 *Ibid :* Ch. 8.

4 II, 472.

5 *Aranya :* XLVI, 2.

सर्पाः पञ्चाननाः भूत्वा भक्षयन्ति स्म राक्षसान् ।
येन येन च गच्छन्ति राक्षसा भयकर्षिताः ॥
तेन तेन स्म पश्यन्ति राममेवाग्रतः स्थितम् ।
इत्थं विनाशितं तेन जनस्थानं तवानघ ॥

He closed his description of Rāma's valour with the challenging assertion that Rāvaṇa can no more hope to conquer him in battle than can sinners to win Heaven. If this was irritating, what followed was intriguing in the extreme. It was his flash-light picture of Sītā's beauty!

नैव देवी न गन्धर्वी नाप्सरा न च पन्नगी ।
तुल्या सीमन्तिनी तस्य मानुषीषु कुतो भवेत् ॥

It kindled in the king a spark waiting to be fanned up into a flame. Akampana ended by suggesting that the best method of giving Rāma short shrift was to spirit Sītā away when he was off his guard. But the method did not recommend itself to Rāvaṇa *just then*: it suited neither his mood, nor his egoism, nor his reading of Rāma's character.

But what were Rāvaṇa's thoughts then? To the paranoiac in him the description of Rāma's valour came as an affront. To use a well-known term of psycho-analysis, the Rākṣasa potentate was nothing, if not a victim of the Narcissus complex. Note the characteristic vaunt:

नहि मे विप्रियं कृत्वा शक्यं मघवता सुखम् ।
प्राप्तुं वैश्रवणेनापि न यमेन न विष्णुना ॥
कालस्य चाप्यहं कालो दहेयमपि पावकम् ।
मृत्युं मरणधर्मेण संयोजयितुमुत्सहे ॥[1]

To such a hectic vision, begotten of *hubris*, Rāma appeared to be an arrant coward, a ruthless villain, who was a disgrace to the very name of Kṣatriya, having been banished his kingdom along with his wife, by a justly incensed father. That this was his *prima facie* impression of Rāma is clear from his words to Mārīca in Sarga XXXVI, 10-11.

पित्रा निरस्तः क्रुद्धेन सभार्यः क्षणजीवितः ।
स हन्ता तस्य सैन्यस्य रामः क्षत्रियपांसनः ॥
दुःशीलः कर्कशस्तीक्ष्णो मूर्खो लुब्धोऽजितेन्द्रियः ।
त्यक्तधर्मा ह्यधर्मात्मा भूतानामहिते रतः ॥

This impression was confirmed later on by Śūrpaṇakhā's story. But even as he formed it there was another side of his mind which told him that he might be wrong, that the capture of Sītā might not be all beer and skittles, and that he must exercise caution. So, after treating Akampana to a little swashbuckling, he directed his aerial car to Mārīca's Āśrama for a preliminary consultation. Where was the need for it if he was sure

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[1] *Aranya*: XXXI, 5-6.

of Rāma's insignificance? This Mārīca, who had escaped with the skin of his teeth from Rāma's arrows and known their full power, had subsequently in sheer dread turned a *parivrājaka*, devoted to asceticism and meditation. He was a clairvoyant, with the Protean power of changing his form as he liked. In the days before his reformation he combined redoubtable courage with mastery of all the wily ways of Rākṣasa warfare. Hence it was that Rāvaṇa naturally turned to him for advice and help. But in his first visit he got from him but a douche of freezing mixture, and had to return to Laṅkā, rebuffed and chagrined.

Now comes before him Śūrpaṇakhā telling her tragic story and charging him with not having realized the dire peril in which he and his kingdom stood from the formidable foe who had now implanted himself in Janasthāna. In brief words and a memorable image she draws a picture of Rāma's martial prowess, his captivating beauty of person and—curious to note—his spiritual greatness.[1] All this, however, flows off his mind, like water off a duck's back. But anon, when she turns to the praise of Sītā's beauty—with its *ne plus ultra*—

। देवतेव वनस्यास्य राजते श्रीरिवापरा ।

he pricks up his ears. The passion kindled by Akampana flames up and becomes a clamant obsession. She advises him to gird up his loins forthwith and race to Rāma's Āśrama in Pañchavaṭi, make short work of him and Lakṣmaṇa, and "carry Sītā off for wife, all in the approved fashion of Rākṣasa marriage."[2]

स्वधर्मो रक्षसां भीरु सर्वदैव न संशयः ।[3]

Like Lady Macbeth, Rāvaṇa "sees the future in the instant." The very thought of the adventure thrills him—ततः शूर्पणखावाक्यं तच्छ्रुत्वा रोमहर्षणम्. Incontinently he whisks off again to Mārīca's Āśrama. After describing Rāma in the contemptuous terms, already quoted, he bespeaks Mārīca's help for an enterprise he has in mind. Mārīca should assume the form of a silver-spotted golden deer and roam about in front of the Āśrama in Pañchavaṭi. In her excited longing for the thing of wonder Sītā was bound to tell off her husband and Lakṣmaṇa to capture it. When they are in its quest, he (Rāvaṇa) can without the least hitch or jeopardy carry off Sītā. Then will Rāma become a grief-stricken spectre and can be struck down at leisure. At these words a mortal terror seizes Mārīca and blanches his face.[4] With a cadaverous look he sets about disabusing his chief of the false notions he has about Rāma: "Do not live in that fool's paradise. Rama is not that vile blot on the scutcheon of the Kṣatriya race and the rest of that flapdoodle that has got into your head." He gives Rāvaṇa a disconcertingly circumstantial account of what took place in Kaikeyi's *boudoir*, and earlier, in Daśaratha's hall of audience at Viśvāmitra's visit.[5] "It was in obedience to the

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1 Sarga XXXIV, 5-12.

2 So, R. Narayana Aiyar in his profound and searching study of the *Plot in the Araṇya Kāṇḍa* (in 'The Krishnamacharya Book of Commemoration'). He blazes a trail in the aesthetic appreciation of the *Rāmāyaṇa*, as much by his insight as by his wide scholarship in four different literatures.

3 *Sundara*: XX, 5.

4 *Araṇya*: XXXVI, 18-24.

5 *Araṇya*: XXXVII and XXXVIII.

dictates of duty that Rāma had voluntarily renounced his kingdom and the seductive call of royal luxuries. He is the embodiment of Dharma, having for his supreme watchword all the world's good,—a hero whose valour was based on and consisted in Truth. Sītā is protected by him with fiery valour as a treasure dearer than his own life. To try to tear her off from him is like trying to rob that fountain of splendour, the Sun, of his radiance. To venture within the range of his arrows is to court certain destruction in a blaze kindled by his weapons."[1] Well, here was a facer! He could not possibly doubt the truth of Mārīca's words,—words born of dire experience that seemed to come tearing from the heart of one in whom he had the highest confidence. But the warning which would have dissuaded the wildest desperado, had just the reverse effect on Rāvaṇa's mind. Instead of giving up his project, he gave it a finer edge, armoured its sides and made it more subtly efficient. But for Mārīca's grim warning Rāvaṇa would have gone ahead and failed in his venture. Now it had a strange and unanticipated result. It acted as a challenge to his intelligence. His passion for Sītā, now grown too imperious to tolerate any frustration, sharpened his wits. "Well," replies Rāvaṇa in effect, "if Rāma and Lakṣmaṇa are so formidable, and if Sītā is minutely and hourly watched and protected by at least one of them, I can see a way of outwitting them both, by taking them both away from her side. Assume thou the form of a golden deer and lure Rāma to a safe distance and cry in imitation of Rāma's voice—'Oh, Sītā ! 'Oh, Lakṣmaṇa !' Deceived by these words she will urge Lakṣmaṇa to hasten to her lord's help. It will then be a walk-over for me."[2] Mark the treacherous design of the man. Knowing full well that Mārīca was doomed, he baits his demand with a bribe. With cozening irony he says: "राज्यस्यार्धं प्रदास्यामि मारीच तव सुव्रत."[3] What a solatium ! And still more Mephistophelean—super-Hitlerian—is the concluding eye-wash mixed with open threat. Mr. R. Narayana Aiyar astutely brings out the spirit of it : "Having accomplished my object, I shall return to Laṅkā, with Sītā, and with you too,—that is, if you, Mārīca, have the good luck to escape, though, to be sure, you will be *de trop* in my aerial car now. Cheer up ! He will probably slay you if you go with me ; I shall certainly kill you if you don't."[4]

आसाद्य तं जीवितसंशयस्ते मृत्युर्ध्रुवो ह्यद्य मया विरुध्य ॥

We have here a threefold *peripeteia*. But before we unravel its strands we must explain the term itself. Aristotle's illustrations in the *Poetics* make his meaning clear. What Aristotle says of it in Chapter XI is rightly interpreted by F. L. Lucas : "A peripeteia occurs when a course of action intended to produce a result X produces the reverse of X. Thus the messenger comes to cheer Oedipus and free him from his fear of marrying his mother, but in revealing who Oedipus really is, he produces exactly the opposite result. Again, in the *Lynceus*, the hero of that name is led off to execution, while Danans goes with him as his intending murderer ; but the upshot is that Lynceus escapes while Danans is killed

1 *Araṇya :* XXXVII, 12-17.
2 *Ibid :* XL, 19-22.
3 XL, 23.
4 *Op. cit.*, 71.

himself."[1] *Peripeteia* does not mean, as it is ordinarily understood, "a reversal of fortune," but "a reversal of intention," —"an unexpected catastrophe from a deed unwittingly done." "It is piteous," says Aristotle, discussing the source of pity in his *Rhetoric*,[2] "that an evil should befall from a quarter whence good fortune is due." As J. W. H. Atkins points out, *peripeteia* "introduces into a play the irony of circumstances, and is thus to the action what verbal irony is to language."[3] There is peripeteia (*i*) when Mārīca by his advice and warning produces a result just the reverse of what he contemplated. We have it again (*ii*) when Rāvaṇa starts on his venture with the delusion that he is out to achieve the crown and consummation of his joys—the Ultima Thule of his fortune,—while in reality he was taking the first step towards his own doom. While he lay in ambush for Sītā, his Retribution lay in ambush for him. If the golden deer exercised a fatal fascination on Sītā, she in turn was the fatal golden deer to him. We have the *peripeteia* again (*iii*) when Sītā longing for the seductive phantom opens for herself the gateway of sorrow.[4]

V. THE 'HAMARTIA'

Rāvaṇa's scheme was not invulnerable. It failed to take into account one vital factor. He was quite sure that both the brothers would fail to see through the decoy of the मायामृग. But, as a matter of fact, in Lakṣmaṇa's penetrating discernment there was an Ithuriel's spear, with an unfailing potency to perceive and unmask the most treacherous of disguises. It would have wrecked the abductor's plan at the very start, but for an unforeseen factor that came to his aid.

What was that factor ? As soon as Lakṣmaṇa sees the Golden Illusion, he warns his brother and tells him that it was no real deer but the wizardry of Mārīca.

मृगो ह्येवंविधो रत्नविचित्रो नास्ति राघव ।
जगत्यां जगतीनाथ मायैषा हि न संशयः ॥[5]

But Sītā's infatuation with the deer-shaped Wonder was so great that her judgment was blinded :

उवाच सीता संहृष्टा छद्मना हृतचेतना ॥
आर्यपुत्राभिरामोऽसौ मृगो हरति मे मनः ।[6]

The infatuation seems to infect Rāma himself, who launches into a rhapsody on the deer, comparing it to the deer in the starry sky—मृगशीर्ष—

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1 *Tragedy* : p. 92. See his detailed discussion in the Classical Rev., XXXVII, 1923 and W. Lock's Essay "Use of Peripeteia in Aristotle's *Poetics*."

2 II : VIII, 10.

3 *Literary Criticism in Antiquity*, pp. 91-92.

4 The first instance of this reversal of intention and irony of circumstance occurs in the *Ayōdhya Kānḍa*, when King Daśaratha and citizens, preparing for the coronation of Rāma unwittingly prepare the ground for his exile.

5 *Aranya* : XLIII, 8.

6 *Ibid* : LIII, 9-10.

the Orion.[1] But he realizes that it is one of the endless frauds of Mārīca, and sets out in its pursuit after solemnly adjuring his brother to keep vigilant guard round the Āśrama.

Under no circumstances, except one as we shall see, would Lakṣmaṇa desert his post as guardian of a sacred trust. He was bound to it by his vivid sense of the danger lurking in the forest, his own sense of duty, and his brother's command. His presence there was like a steel fortress to any enemy—a grim enough barrier in Rāvaṇa's path. But, impregnable as it was, it was demolished at one stroke by Sītā's reaction to the situation. When the treacherous cry of Mārīca is heard, she loses all self-control—overpowered indeed by her anxiety for her husband. Vainly does Lakṣmaṇa plead that none in the world can stand against Rāma. In a paroxysm of cruel suspicion and anger she hurls at him a thundering accusation. This is what you think, Lakṣmaṇa :

"He perishes—well, let him die !
His wife henceforth shall be mine own !
Can that thought deep embedded lie
Within thy heart's most secret zone !

Search well and see ! one brother takes,
His kingdom—one would take his wife !
A fair partition—But it makes
Me shudder and abhor my life.

Art thou in secret league with those
Who from his hope the kingdom rent ?
A spy from his ignoble foes
To track him in his banishment ?"[2]

She unconsciously lights upon the one thing which alone had power to chisel off from her side the guardian presence of that knight *sans peur et sans reproche* of the *Rāmāyaṇa*, who suggests at once a Bayard, and a Sir Galahad, but stands unique, whether in history or in fiction.[3] Lakṣmaṇa was not bound—as Rāma was—by any moral code to renounce a life in clover at Ayodhya, to leave his young bride behind—hardly seventeen, as we must infer from Sītā's age in the poem[4]—seal his ears to the siren-song of sex, in the heyday of life, and accept the life of a celibate,—all from love of a brother he adored like a god. It is this knight-errant of the staunchest integrity and honour that Sītā, suffering a temporary estrangement from her better self, charges with lustful leanings towards herself, with being the spy and emissary of Bharata. It is too much for him, and he flies from the words as from hell-blast. But even thus lashed mercilessly, he is all forbearance. His one thought is Sītā's safety—the safety of one he looked upon as a deity.

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1 *Ibid :* 25-38. Vālmīki's golden deer is the reverse of Wordsworth's White Doe of Rylston : "A spirit for one day given,
A pledge of grace from purest heaven."

2 Toru Dutt in *Lakṣmaṇa*. It splendidly brings out the spirit of *Araṇya*, Sarga 45 : See verses 21-25.

3 Lakṣmaṇa's interposition of himself between Vibhīṣaṇa and the deadly javelin (hurled at the latter by Rāvaṇa) has no parallel in any other epic (Eastern or Western). See *Yuddha Kāṇḍa*, Sarga CI. It takes us to the 'O Altitudo' in the realm of moral beauty ; and yet Lakṣmaṇa, like the characters of this epic, is throughout human.

4 *Araṇya :* XLVII, 10-11.

उत्तरं नोत्सहे वक्तुं दैवतं भवती मम [1]

He leaves only after entrusting her to the *Vana Dēvatās*, and bowing to her in reverence :

"And oh ye sylvan gods that dwell
  Among these dim and sombre shades,
Whose voices in the breezes swell
  And blend with noises of cascades,
Watch over Sita, whom alone
  I leave, and keep her safe from harm,
Till we return unto our own,
  I and my brother, arm in arm."[2]

It is by this *temporary* fall from the right attitude to life that Sītā invokes her nemesis and takes a hand in her own misfortune. In Shakespearean tragedy, a slip, a fit of absent-mindedness or a pardonable oddity proves in certain conjunctures to be disastrous. The essence of tragic suffering is that it comes as a punishment, and punishment out of all proportion to the offence. The Poet of the *Rāmāyaṇa*, by a stroke of art, makes Sītā's offence telescope right into Rāvaṇa's fatal decision to carry her off. He makes his crime and her folly shake hands. He makes her at once the agent of his ruin and her own misfortune. The *hamartia* in Sītā reinforces the *peripeteia*. Her weakness contributes to solder the vulnerable joint in Rāvaṇa's project. The scene may rightly be regarded as the very fulcrum of the *Rāmāyaṇa*. With marvellous art the Poet places cheek by jowl the two scenes (Sargas 45 and 46)—the one that shows the back-sliding of the heroine, and the other that shows her in one of her charming facets—her guilelessness and hospitality to those worthy of reverence.[3] Even when Rāvaṇa, in his rôle of pseudo-Sanyāsin, praises her physical charms like a poet of the Fleshly School, no suspicion of a base motive enters her mind. Mark the irony of it : while she suspected Lakṣmaṇa she does not suspect Rāvaṇa ! Fair is foul and foul is fair !

The type of *hamartia* exemplified here will be clear if we recall what Aristotle says about it : "The word *Hamartía* by usage admits of various shades of meaning. As a synonym of *Hamartēma* and as applied to a single act, it denotes an error due to inadequate knowledge of particular circumstances. According to strict usage we should add the qualification, that the circumstances are such as might have been known. Thus it would cover any error of judgment arising from a hasty or careless view of the special case ; an error which in some degree is morally culpable, as it might have been avoided. But *hamartia* is also more laxly applied to an error due to unavoidable ignorance, for which the more proper term is *ātukhía* 'misfortune.'

Distinct from this, but still limited in its reference to a single act, is the moral *hamartía* proper, a fault or error where the act is conscious and intentional, but not deliberate. Such are acts committed in anger or passion. Lastly, the word may denote a defect of character distinct

[1] XLV, 28.

[2] Toru Dutt.

[3] For her trait, her divine compassion and forgiveness, see *Yuddha Kāṇḍa* : CXVI, 37-44, and *Sundara* : LVIII, 89.

on the one hand from an isolated error or fault, and, on the other, from the vice which has its seat in a depraved will. Under this head would be included any human frailty or moral weakness, a flaw of character that is not tainted by a vicious purpose."[1]

What we have in the third Book of the *Rāmāyaṇa* is "The moral *hamartia* proper, a fault or error where the act is conscious and intentional, but not deliberate. Such are the acts committed in anger or passion."

But the misfortune of the hero does not come under this Aristotelian principle of Tragedy. It follows in his case from his sublime moral idealism. We have similar examples of calamity following loyalty to a moral ideal in plays like Arthur Schnitzler's *Professor Bernhardi*, Ibsen's *An Enemy of the People*, Galsworthy's *Mob*, Aeschylus's *Prometheus Bound*, Shelley's *Prometheus Unbound* and Shaw's *St. Joan*. History illustrates it in the lives of the martyrs for truth and justice from Socrates, Papinian and Ulpian to Nurse Cavell.

In Vālmīki's epic we have a blend of the central principle of Shakespearean Tragedy—the conspiracy of Character with Destiny—with that element noted above, exemplified in history and tragedy.

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1 Butcher: *Aristotle's Theory of Poetry and Fine Art*, pp. 317-19.

गाणादउमन्कुरू शंदेन.सादश्राम दिनायाण कसा णा विरत्वमान इति समा गावा इंगल
श्रुष्टरः॥मरविनादउमाः यांश्रीनागवतनाव.वंदाि नामसमाप्रा॥७॥ समाप्ता॥७॥ ग्राथाग्रं १२०॥



DISCOVERY OF A FOLIO OF BHĀGAVATA DAŚAMASKANDHA

ILLUSTRATED IN THE GUJARATI STYLE

By

PROFESSOR M. R. MAJMUDAR, M.A., LL.B., PH.D.,

Baroda College, Baroda

INDIAN painting can be best understood if it is considered as only a different kind of medium for the expression of various flavours (*Rasas.*) The subject-matter of poetry and painting is the same. Love, legends and religion furnish the staple themes for both and consequently our poets and painters have to be judged according to the settled conventions of Rhetoricians.

The themes of Gujarāti painting are primarily Religious (dealing with the life-stories of Jaina Tīrthaṅkaras, the Kṛṣṇa cycle, the Śaiva Śākta and Vaiṣṇava mythology in general), and less typically, Secular (erotics, love-romances, history, etc.). The paintings are principally given a contemporary environment in town and village life, which fact permits an exquisite delineation of every phase of Gujarāti life in general. Stylistically, therefore, Gujarāti paintings after the 16th century, hardly show any approximation to indigenous Gujarāti style, being closely mixed up with the Rajput and Mughal schools.

All the illustrated Mss. of non-Jaina subjects both religious and secular, so far traced from Gujarāt, belong to the second period of Western Indian painting *i.e.*, 'the paper-period' from 1400 A.D. onwards.[1] Barring the Jaina and Bauddha miniatures on palm leaf of the first period (1100—1400 A.D.) no illustrated Brahmanical Ms. on palm leaf has yet, to my knowledge, come to light. The Brahmanical miniatures on wooden covers dating from 12th and 13th centuries from Nepal are, however, in existence.[2]

The reasons for this can be surmised. The Jaina and Śramaṇa communities achieved a systematic organization of Upāśrayas, Gachchas and Vihāras, supplemented with amenities received from royal patronage as well as from rich nobles, during the Hindu rule and the rule of the Gujarāt Sultanate as well. Accordingly, there came into existence monuments, monasteries and schools. To this development of a cult corresponded a literary, scientific and artistic activity, of which the results in the field of miniature-painting are preserved in the famous Bhaṇḍāras

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1 For discussion of the "Periods of Western Indian Paintings," see the "*Story of Kālaka,*" edited by Prof. W.N. Brown (1933, Washington), pp. 13-24; Ch. II: "Miniature Paintings in Western India: 12th to 17th century."

2 "*Some Brahmanical Miniatures from Nepal,*" by P. C. Bāgchi, *Journal of the Indian Society of Oriental Art*, 1940.

scattered over the whole of Western India, especially in Gujarāt and in Rajputānā. The Sādhus using the illustrated Mss. for sermons to the laity, left them in charge of some secure place or agency on their death ; hence they were handed down to the next generation without any tampering, damage or loss.

The same arrangement, unfortunately, did not help the preservation of Brahmanical learning and the artistic treasures of Gujarāt during the same period. Brāhmaṇas, the repositories of Brahmanical tradition had to depend on individual efforts of preservation, patronage and propaganda. That is why no old Mss. of non-Jaina miniatures have come down to us. However, paper Mss. of the second period are in good evidence from the 15th century onwards.

It is also surmised that the Mussalman raids in Gujarāt which led to the repeated sack of several old centres of Brahmanical learning, *viz.*, Ānandapura (modern Vaḍnagar), Prabhāsa and Dvārkā, were mainly responsible for the disappearance and destruction of such materials of highest cultural value. And the rich libraries of learned Paṇḍits being not taken care of by their less educated progeny, were allowed to be looted, ransacked and destroyed ; and thus they could not form a cultural heritage to the next generation as it used to be with respect to the Jaina Sādhus.

The most prolific sources of materials for the school of Western Indian miniature-painting are the numerous palm and paper Mss. of two Śvetāmbara Jaina works, the '*Kalpasūtra*' and the *Kālakācāryakathā*. To this, however, may be added those outside the Jaina environment, the equally popular—Śākta series of the *Devī-māhātmya*, the Vaiṣṇava miniatures of the *Bhāgavata Daśamaskandha*, the *Gītagovinda* and the *Bālagopālastuti*, lying scattered over several private collections of Brāhmin families of old literary tradition.

The Vaiṣṇava miniatures from Western India comprising of the *Bhāgavata* folio, the *Gītagovinda* and the *Bālagopāla stuti* belong to the second period of Western Indian Painting as were also the earliest Śākta miniatures from the *Devī-māhātmya* (published in *J.I.S.O.A.* for 1939 and the *New Indian Antiquary* for 1939) and the secular miniatures of the now too well-known *Vasantavilāsa* and the *Ratirahasya* (published in the *Bombay University Journal* (1937).

If Śaivism had prompted philosophy, architecture and sculpture in the South, Vaiṣṇavism had inspired poetry, music and painting in the North and the West of India. The *magnum opus* of Vaiṣṇava Bhakti Śāstra is the *Śrīmad Bhāgavata*. Here is shown the application of the principles of Bhakti to the devotion of Viṣṇu and to His great manifestations—*avatāras*, and the Vaiśṇava saints, who have become one with him. The *raison d'être* of the *Bhāgvata* was that in the *Mahābhārata*, Vyāsa, its author had omitted the treatment of Bhakti ; and it was to make up that want that he brought out this work. While the *Harivaṃśa* and the *Viṣṇupurāṇa* each gives some account of Kṛṣṇa's boyhood spent among the Gopas and Gopīs of Vṛndāvana and its neighbourhood, they deal with the whole life of Kṛṣṇa.

The *Bhāgavata*, however, scarcely refers to his later life, and spends all its strength over his boyhood and youth. Hence the hold it has had

on some of the best Vaiṣṇava communities, and many of the noble minds of India. What distinguishes the *Bhāgavata* from all earlier literature is its new theory of Bhakti ; and therein lies its greatness. Some of its utterances on this subject are worthy of a place in the best literature of mysticism and devotion.

Bhakti-ratnāvali which is a selection of the finest utterances on nine-fold forms of Bhakti from the *Bhāgavata*, is arranged according to subjects in 13 groups. The author Viṣṇupuri (Cira 1400 A.D.) has called each of these collections a string of gems (*Virachana*), and named the whole as "the Necklace of Bhakti Gems"—the best introduction to *Bhāgavata*—Bhakti, presented in a popular form.

One illustrated among several Ms. copies of the *Bhakti-ratnāvali* met with in Western India, illustrating some of the incidents from the text, coming as it does from Gujarāt proper (it having been copied in Ahmedābād in Samvat 1806, 1750 A.D.), makes it evident that this Vaiṣṇava work was very popular on this side of India, and that the style of these miniatures is the one that was prevalent in Gujarāt in the 18th century. This brings the art of miniature-painting in Gujarāt down to the time of contemporary Mughal and Rājput influences.

The signs of decadent Mughal and Rajput schools of painting are in evidence in these miniatures of the *Bhakti-ratnāvali* ; however, at places, the dress, the landscape and other details help one to identify them as belonging to the indigenous Gujarāti style of painting, which was in demand in those days.[1]

Gujarāt, through its famous pilgrim-centres of Prabhāsa-Paṭṭan and Dwārkā, is intimately connected with the cult of Śri Kṛṣṇa where the ever-moving caravans of pilgrims from all parts of India used to bring with them devotional songs and prayers, that gained a wide currency and spread from there.

That is why Gujarāt has been specially associated with various forms of Vaiṣṇavism. The spread of Jayadeva's '*Gītagovinda*' in Gujarāt within a few years of its composition and the diffusion of Vaiṣṇava works of Bilvamaṅgala such as the *Kṛṣṇa Karṇāmṛta* and the *Bālagopālastuti*, the *Bhakti-ratnāvali* of Viṣṇupuri and the *Viṣṇubhakti-Chandrodaya* of Nṛsimhāraṇya Muni in Western India is explicable only as a result of constant pilgrimages undertaken by saints. It is a fact that Lord Chaitanya first heard of the '*Bhakti Rasayāna*' when he had been to Dwārkā. This work, it is said, he carried with him thence.

The subject of the *Gītagovinda*—the lyrical drama, singing the song celestial in praise of Lord Kṛṣṇa, is the love of Kṛṣṇa for the beautiful cowherdess Rādhā, the estrangement of their love and their final re-conciliation. There are four aspects in which the work is viewed by Indian readers : (i) literary, (ii) devotional, (iii) musical and (iv) metaphysical. All these views combined have led to the wide popularity of the poem, all over India. The ten incarnations of Vāsudeva Kṛṣṇa are of universal acceptance among the Hindus : and thus the popularity of the *Gītagovinda* on this score has not suffered in the least in spite of its

1 For reproductions of some of these miniatures see my paper in the *Journal of the University of Bombay*, September 1939 : *Saint Viṣṇupuri and his Bhakti-Ratnāvali.*

Śṛngāric note—the sensualism in full bloom—woven in sweet words of exquisite music.

But it appears that only the devotional side of the *Gītagovinda* has found greater appeal in Gujarāt, especially the portion relating to the ten *avatāras* of Śri Kṛṣṇā. Jayadeva the author, too, is looked upon more as a *Bhakta* than as a Poet, as he figures in Nābhāji's *Bhaktamālā* (Samvat 1689). The next significant mention of the poet and saint Jayadeva is found in the *Suratasaṇgrāma*, a Gujarāti poem by the Saint poet Narasimha Mehtā (15th century A.D.), which narrates in a forcible style a sham fight between Kṛṣṇa and his companions on one side, and Rādhā and her friends on the other. During the course of this fight Jayadeva has been introduced as a *Viśtikāra* to carry on negotiations on behalf of Kṛṣṇa's side. The poem is also reminiscent of several phrases from Jayadeva's work.

The early popularity of the *Gītagovinda* in Gujarāt is discernible in the stone-inscription of Sāraṇgadeva, dated Samvat 1348 (1291 A.D.), which records the levying of a revised tax from the inhabitants of Pālanpur, to defray the expenses of the *naivedya*, *pūjā*, *prekṣaṇīyaka*, (offerings, worship, dramatic performances) etc., of Lord Kṛṣṇa, re-installed there, from an ancient temple.

The invocation verse in this inscription is the last verse of the first canto of the *Gītagovinda* styled the *daśāvatārastuti* ; and this fact shows that the work composed in the last quarter of the 12th century had already become quasi-sacred within a century, within which period it travelled to distant lands—from the east to the west of India—and found one of its verses inscribed on a stone ! This points out how the cultural unity of India continued to be fundamentally one and undivided, and it explains also how through the itinerant saints, Jayadeva's work came to be made known to this part of India.

The illustrated paper Ms. of the *Gītagovinda*[1] in the Gujarāti style with miniatures identical with those of the *Kalpasūtra*, the *Vasantavilāsa* and the *Bālagopālastuti* is important ; it provides one more document, testifying to the prevalence of the common provincial tradition of miniature-painting in Western India, which is not only outside the Jaina Śvetāmbara environment, but is positively Vaiṣṇava in theme.

The pure Gujarāti style of the extant miniatures leaves no doubt as to the probable date of the Ms. on stylistic grounds, which cannot be later than the middle of the 15th century. It is thus the earliest illustrated Ms. of the *Gītagovinda* in India, so far known to us.[1]

The new find of the last folio of the *Bhāgavata Daśama Skandha* introduced through this paper, adds one more document to this section of Vaiṣṇava miniatures, done in the pure Gujarāti style of the second, *i.e.*, the paper-period from 1450 A.D. to 1600. This folio from the Mss. collection of His Holiness Śri Vrajabhūśaṇalālji Mahārāja, a descendant of Śri Vallabhāchārya, of Kānkaroli near Nāthadwārā (Mewāḍ), was announced last year.[2]

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1 For reproductions in colour of the extant miniatures, *vide* my paper on "A Fifteenth Century Gītagovinda Ms. with Gujarāti Paintings," *Journal of the University of Bombay*, May 1938.

2 *Vide* my paper on "A Newly Discovered Illuminated Gita-Govinda Ms. from Gujarāt ; late 15th century A.D." in *Journal of the University of Bombay*, for September 1941, p. 119, foot-note.

The folio reproduced here with his kind permission measures 9¾" X 5¾" and contains the colophon[1] on the top, which makes use of *pṛṣṭhamātrā* in its calligraphy. The miniature with Śri Kṛṣṇa playing on the flute in the centre and a pair of Gopis on either side represents the very ancient idea of symmetry of composition. The facial outline, the short chin, the dress, ornaments, pose and the very technique, are in the direct line of style continued from the time of the *Kalpasūtra* Mss. The big circular earrings, the *mukuṭa* both on male and female figures, the braid of hair with a tuft hanging below the waist, and the twisted curl touching the cheek are some of the familiar points noticeable in this folio.[2]

The figures are on a brick-red background; the use of saffron yellow, green, light-blue and rose follows the older tradition. The horizon or the skyline is shown by touches in blue and the figures on earth are differentiated from it by wavy arch-like lines.

The only noteworthy feature in the delineation of the figures that is conspicuous by its absence is the further eye, as it is called, which used to be shown as superimposed. This miniature is, as it were, a landmark in the history of Indian book-illustrations which records the transition from the three-quarter profile to the strict profile, which came to stay since the early 16th century miniatures of the Southern Rājasthāni style. We can assign on stylistic grounds, a corresponding or an earlier date, somewhat late 15th century A.D. to this painting of a Vaiṣṇava theme. On the back of this folio is pasted the entries of a *Khata* or document of lendings (which clearly bears the date 1690 Samvat, Kārtik) between persons connected with the Vaiṣṇava temple. This indirectly gives us some clue as to the farthest limit of the original folio.

All Gujarāti paintings exhibit marked peculiarities in the delineation of the human form, the most conspicuous being those of the three-quarter profile position in which the further eye protrudes unnaturally and the long pointed nose projects beyond the outline of the cheek. A semi-circle slightly emphasised or pointed at the corners, with a single curve for the brows has been enough to make up the eyes, almost stretching to the ears.

But here in this folio, the face of Kṛṣṇa playing on the flute and especially the faces of the Gopīs turned towards Kṛṣṇa arranged in a symmetrical group, with hands held up in a pose of reverence and ecstasy are shown in clear profile. Of course, the one end of the eye is elongated so as to touch the ear as is obtained in earlier specimens.

In a like-fashion, "in the illustrations of the *Amaruśataka*[3] the figures invariably have their large heads shown in profile; they are sharply

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[1] The Colophon reads :—"राणे दशमस्कन्धेऽष्टादश साहस्रां संहितायां श्री श्रीकृष्णावतारचरित्रवर्णने नवतितमोऽध्यायः । इति श्री श्रीधरस्वामि रचिता दशमा .... या श्री भागवतभावार्थदीपिका समाप्ता । ग्रंथाग्रः ६०० ॥"

[2] Thanks are due to Śriyuta Kanṭhamaṇi Shāstri of Vidyāvibhāga Kānkaroli, to Śāstri Keśavarām of Gujarāt Vernacular Society Research Dept., Ahmedabad, to Sheth Śri Toḍarmal Sāmal Bechar and to Prof. G. H. Bhaṭṭ, M.A., both from Baroda, for arranging to place the folio at my disposal for study and for reproduction.

[3] Dr. Stella Kramrisch : "*The Hundred Verses of Amaru Illustrated.*" *Journal of the Indian Society of Oriental Art*, Vol. VIII, 1940, pp. 238-39.

turned sideways while the body is in the three-quarter profile or front view ; the hips and legs again in profile. This is typical also of Indian illustrations of which examples have survived from the 12th century onwards in Western India illustrations, part of the averted half of the faces (in the earlier illuminations), and in any case its large and but little foreshortened eye, are outlined against the background. Here as well as there, limbs move freely within the space built up by the body and its turns."

Kṛṣṇa wears a *dhoti* or a *pītāmbara* (literally and actually in the miniature, *a yellow garment*) reaching to the ankles, with a short scarf thrown across the shoulders, leaving the upper-half of the body uncovered. Both the cloths are printed in diverse designs.

The V-shape Vaiṣṇava marks are visible not only on the forehead but also on the body of Śri Kṛṣṇa. The *mukuṭa* or head-gear is typically Indian. The *tribhaṅga* pose (having three bends in the standing straight line) gives a lyrical delicacy to the portraiture. The flute, held by both the hands, the end of which extends to the other side, balances the entire composition.

The symmetrical figures of Gopīs, two on either side, each of them so placed as to face the central figure, are typical of female portraiture met with in Western India paintings from the 12th to the 16th century. Three of these have the right hand held up in a gesture of admiration or of ecstasy, and the one standing close to Kṛṣṇa and seeing him face to face, has the palm spread out towards him, perhaps suggesting complete self-dedication of her soul to Him.

These full-bosomed and narrow-waisted Gopīs wear variegated hues in their close-fitting bodices remaining up above the navel, and covering the arm almost up to the elbow. Like Śri Kṛṣṇa, the Gopīs are dressed in floating scarf and waist-cloth adorned with various printed patterns. The *Sāri*, covering the head, of the later Rājput period has not yet made its appearance. Transition from the use of a single bangle to a group of several on the hands of the Gopīs is also noteworthy.

A tuft of hair artistically twisted so as to touch the cheek, the long hair adorned with flowers hanging in a single braid ending in a black tassel, the circular earrings and the *mukuṭa* in the case of the Gopī painted to the farthest right—are facts sufficient to establish the direct relationship and the continuity of the older tradition in representing female figures in Western India Paintings up to the second period of the style, *i.e.*, roughly from 1400. A.D. to 1600 A.D.

The blue narrow strip of horizontal lines reaching almost the top of the miniature, represents the conventional sky, a motif that was later on handed down to and adopted by the Rajput painters. The wavy arch-like line circumscribing the brick-red background creates, as it were, an architectural setting for the figures that form the main theme of the illustration.

This folio, on the whole, does not illustrate the words of the text ; but, all the same, it shows the mood and setting of the predominant and the popular note of the Tenth Skandha of the *Bhāgavata* and leaves the atmosphere of Vaiṣṇava lyricism to establish itself at the end.

THE SORICARITTA: A PRĀKRIT KĀVYA

By

PROFESSOR A. N. UPADHYE, M.A., D.LITT.,

Rajaram College, Kolhapur

[(1) The Soricaritta, Introduced for the First Time.—(2) Mss. Material Used and their Peculiarities.—(3) The Contents, etc., of the First Canto.—(4) Śrīkaṇṭha, the Author, Distinguished from others of that Name; and his Works, Pupils and Date.—(5) The Commentator and his Commentary: (*a*) Authorship of Trivikrama-sūtras; (*b*) Difficulties Facing a Student of Prākrits; (*c*) Use of *ḷ* in Prākrit.—(6) The Prākrit Text of Canto 1.—(7) Extracts from the Commentary Re-arranged.]

1. WITH the discovery of certain Prākrit poems such as the Kaṁsavahọ,[1] Usāṇiruddhaṁ,[2] Siricimdhakavvaṁ,[3] etc. in the extreme South, it has been possible for us to get an appreciably fair idea of the form and tendencies of literary Prākrits, as evolved in the closing period of their career and as cultivated in areas where Dravidian languages are spoken. In this paper, it is proposed to introduce one more Prākrit poem, the Soricaritta (Sk. Śauricaritra) of Śrīkaṇṭha.

2. Unfortunately no complete Ms. of this Soricaritta (SC) has come to light so far. The Madras Ms.[4] abruptly ends in the fourth Āśvāsa. Both the Trivandrum Mss. (Nos. 105 and 560, Trivandrum Ms. Library) also are incomplete: one contains about 1600 and the other about 1800 Granthas. Whether it contained eight cantos like the Raghūdaya of the same author can be ascertained only when a complete Ms. comes to light.

The text of the First canto of SC and the re-arranged extracts from the Sk. commentary are entirely based on a careful transcript of the Trivandrum Ms., No. 105, Travancore University Library, though some extracts from Madras Ms., especially at the opening of it, are consulted by me. The transcript has got a few gaps, but it is fairly accurate. Some of its peculiarities, however, deserve to be noted. It uniformly uses *ḷ* for *l* in the Prākrit portions, but not in the Sanskrit commentary. At times *k* and *t* are confused: *ghemkūṇa* for *ghettūṇa* (verse Nos. 31, 40). Very often, almost as a rule, Anusvāra symbol is used on the previous consonant instead of doubling the following consonant: for instance, *jaṁtha*, *caṁkhu*, etc., for *jattha*, *cakkhu*, etc. This has arisen, I feel no doubt, from the fact that the copyist has misunderstood the Nōlli, a fat zero, as a symbol of Anusvāra. In fact, in one verse, No. 38, the expected *ṇicco* is written as *ṇithaco*, the Devanāgarī *tha* being just a misrepresented relic of a fat zero between *ṇi* and *co*. In the Prākrit portion, it is the Anusvāra and not the Parasavarṇa that is uniformly used. Lastly, *m* is retained at the end of a pāda. These peculiarities are normalised in

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[1] Hindī Grantha Ratnākara Kāryālaya, Bombay, 1940.

[2] *Journal of the University of Bombay*, X. 2, September 1941.

[3] *Bhāratīya Vidyā*, Bombay, III. 1, November 1941.

[4] Government Oriental Mss. Library, Madras, No. 4312.

the light of present-day editorial conventions : *l* is uniformly used ; conjunct-groups are duly represented ; Anusvāra mark is regularly used in the Prākrit text ; and Anusvāra is put at the close of a metrical foot. After normalising these peculiarities, there hardly remained any readings on which there was felt the need of giving improved forms. Minor scribal errors could be easily eliminated, because the *anvaya* of the text in the commentary repeats the Prākrit words. As the text is based on a single Ms., the question of various readings does not arise at all ; it may be noted, however, that the Sanskrit commentary records certain alternative readings : *sumaraha* for *paṇamaha* (verse 4), *sahasaṁ* for *sarasaṁ* (verse 5) and *āsī* for *atthi* (verse 45). The Sanskrit commentary is not given here as it is in the Ms. I have taken here only select extracts and re-arranged them according to the pādas of the verse which are designated as a, b, c and d. I believe, I have not omitted any important portion of the commentary which would be necessary to understand a verse, though it has been my aim to give minimum quantity of extracts. It may be noted that the commentary equates the verbal form of the Present in Prākrit with that of the Past (Imperfect) in Sanskrit.

3. As the title indicates, the poem is composed to describe the acts of Kṛṣṇa (and Balarāma). To begin with, the author offers salutations to Gaṇapati, Sarasvatī, Kṛṣṇa and Īśvara-Pārvatī (1—4). Then he remembers his revered fellow-students Rudra, etc., who have been very kind to him ; it is the interest of his fellow-students in him that made him compose this poem ; a poem without poetic flash contains no life : it is a flower without fragrance ; still the poet, through his devotion to Hari, has composed a Kāvya in Prākrit, so that the wicked critic might have the pleasure of finding faults in it ; and he wants the readers to attend to this blissful Śauri-caritra which is composed in short and which serves a great purpose (5—10).

The earth, assuming the form of a cow, approached Brahman with tears in eyes, and requested him to redeem her from the oppression of Daityas ; but he directed her to Hari who is the efficient cause and the supporter of the world and whom she approached in the company of gods (11—13). Vasudeva had a son Balarāma from Rohiṇī ; and Devakī gave birth to Kṛṣṇa who possessed auspicious signs. Vasudeva took him to Vrajamahī where he became an object of joy to Yaśodā whose daughter, a terror to Kaṁsa, was brought in exchange to Devakī. Kaṁsa apologetically requested Vasudeva and Devakī to put up with the destruction of their children and pleaded not guilty by saying that the beings suffered for their past Karmas. But his hypocritical words had no effect on them (14—22).

Kaṁsa ordered his wicked ministers to destroy the children and ascetics, to smash religious rites and to arrest the gods. That king of Bhojas attempted the life of these boys through Dhenuka, Pūtanā, Śakaṭa, Tṛṇāvarta, etc. (23—30).

Balarāma and Kṛṣṇa, whose bodies were dusty as they crawled on the ground, were lovingly kissed by their mother ; Yaśodā embraced Kṛṣṇa; and the saints repeated their names with reverence. They were an object of joy for the Gopīs ; and the time of the Ābhīras, as they talked about their adventures, passed like a moment. Kṛṣṇa was a terror to the demons ; and he used to steal curds belonging to cowherds : thus

he grew seven years old. As he stole cow-products, he was bound to the mortar which he pulled through the interspace between the pair of Arjuna trees and broke them. Nanda kissed him with joy, and cowherds greeted him with praise (31—41). Then the cowherds went to Vṛndāvana, which presents manifold scenes and near which flowed the river Kālindī that looked like the braid of hair of the earth (42—48). Kṛṣṇa burnt the throat of Bakāsura who tried to swallow him ; he killed Aghāsura who had assumed the form of a boa-constrictor. Both Balarāma and Kṛṣṇa approached the river Kālindī for sports, and she was pleased to seek Kṛṣṇa's shelter. Kṛṣṇa sported there in the company of Gopālas, and overpowered the serpent Kāliya. Dwelling there overnight, next morning he left for Vraja country (49—60).

This short summary of the contents of the first canto clearly indicates that the work primarily deals with the life of Kṛṣṇa. The author has his hands tied down due to the restrictions of Yamakas in every verse ; so very often he is forced to pay more attention to descriptions, etc., than to mere narration of events. Most of the adventures from the early life of Kṛṣṇa are covered by the first canto ; and it is difficult to conjecture how the contents might have been distributed over the remaining cantos, because only the first canto has reached my hands. The author is capable of lucid composition decked with poetic embellishments ; but due to Yamakas, the interpretation of the verses is rather difficult. Many verses would not have easily yielded consistent meaning, if there was no Sanskrit commentary ; and even after using it, some difficulties still remain.

4. The title of the Ms. informs us that the name of the author is Śrīkaṇṭha, and this is confirmed by the verse No. 2 at the beginning of the commentary. Referring to the 'Author Index of Sanskrit Mss. in the G. O. Mss. Library,' Madras 1949, p, 109, I find that the following works stand against the name Śrīkaṇṭha : 1. Madanamahotsavabhāṇaḥ (D. 12577), 2. Mālavikāgnimitravyākhyā-Guṇottarā (R. 602, R. 1836), 3. Raghūdayam with Vyākhyā (R. 3388, R. 2977), 4. Śiśupālavadha-vyākhyā-Bālabodhikā (R. 2732), 5. Sauricarita (R. 4321), and 6. Sūryasiddhānta-vyākhyāvivaraṇam (R. 3730). We have no reason to believe that all the above works are written by the same Śrīkaṇṭha who is the author of our SC. In fact, there have flourished more than one Śrīkaṇṭha ; and with regard to some we get a few facts to enable us to distinguish them mutually.

The author of No. 1 above had another name Nañjuṇḍa. He belonged to Ātreyagotra, and his father was Sāmayārya. He lived at Bālavyāghrapura (Siripuliyur) where there were the deities Viśveśvara and Rāma and where the Bhāṇa noted above was staged at a festival. He mentions his Gurus like Parameśvara, Rāmasvāmi Makhin, Saṅgameśa and Cidambarakavi. This Cidambara was patronised by king Veṅkaṭa I (1586—1614 A.D.) of Vizianagar. So this Śrīkaṇṭha might be assigned to the middle of 17th century.

Of that Śrīkaṇṭha, the author of Guṇottarā, No. 2 above, nothing is specifically known. The author of No. 6 was a pupil of Rudra. The author of No. 4 was a Brāhmaṇa ; his ancestor was one Rudra ; his father and his grand-father were also called Śrīkaṇṭha. Their native place was Jayasiṁhamaṅgala on the banks of the Dakṣiṇa-gaṅgā. He

mentions a neighbouring place called Varakroḍa and perhaps its chief also, through whom his father Śrīkaṇṭha perhaps became friends with one Maheśvara (Parameśvara). He was a Yājñika, and at the request of his Guru and several Yajamānas, he wrote commentaries on Catuṣṭayādi-granthas (?). Once he speaks of a house of Vāriars or Pāraśavas. From this it is not clear whether he is to be taken as a Pāraśava or as a Brāhmaṇa. Later he says that he became a Yājyaśikṣādakṣa and commented on Catuṣṭayādigranthas at the request of Yājyas which would imply that he was a Brahmin.

The Śauricaritra and Raghūdaya (Nos. 5 and 3,) are attributed to one and the same Śrīkaṇṭha, who was a member of the Vāriar caste (Pāraśava) which is traditionally renowned for Sanskrit scholarship in Keraḷa from very early times. He belonged to the family of the teachers of the Zamorins of Calicut. We learn from the Raghūdaya that he was the pupil of his uncle Śaṅkara, and that he lived in a house adjacent to the palace of the Zamorin. He is said to have been one of the court Paṇḍitas of Keraḷavarman, Rājā of Kolattunād in Malabar.

His Raghūdaya is a Sanskrit Yamaka-kāvya in eight cantos. It appears to have been composed on the model of the Nalodaya of Ravideva who is saluted at the beginning of the poem. He is also credited with a treatise on logic called Śrīkaṇṭhīyam.

Śrīkaṇṭha had many eminent fellow-students and pupils. He tells us how his fellow-students were instrumental in his composing the Śauricaritra, and one Rudra by name is specifically mentioned (verse 6). He had a pupil in Rāghava, the author of Padārthacintanam, the well-known commentary on Vāsudeva's Yudhiṣṭhira-vijaya, the great Yamaka-kāvya of Keraḷa.

About the exact date of the SC, there is some difference of opinion. M. Krishnamchariar[5] casually remarks that 'it was composed in Malabar in 1700 A.D.' The Keraḷa scholars[6] would assign him to the first half of the 15th century A.D. We have to await more evidence on this point.

5. The Sanskrit commentator has not given his name anywhere at the beginning. But Professor Warrier informs me that Rudramiśra, who wrote a commentary on the Raghūdayam, is believed to be the author of the commentary on the SC as well, from which extracts are given in this paper. This appears quite probable from the close similarity between the opening verses—

On the Raghūdayam :

श्रीकण्ठरचितस्याहं काव्यस्य यमकात्मनः ।
पदार्थमात्रोपकारि व्याख्यानं कर्तुमारभे ॥

On the Śauricaritra :

श्रीकण्ठरचितं काव्यं तच्छौरिचरिताह्वयम् ।
व्याचिख्यासे सयमकं प्रौढं प्राकृतभाषया ॥

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5 *History of Classical Sanskrit Literature*, Madras, 1937, pp. 370, 371, 373, 512, 704, etc., for references to various authors noted here.

6 Professor M. R. Balkrishna Warrier, and Rao Saheb Ullur S. Parmesvara Aiyar, Trivandrum, nearly agree to this date.

Rudramiśra was also a Pāraśava by caste and a devoted disciple of Śrī-kaṇṭha. There is no sufficient evidence to identify him with one Rudra mentioned by the author as his fellow-student. That a Prākrit Yamaka-kāvya, which is sure to present many a difficulty of interpretation, should be commented upon, in the absence of a *svopajña* commentary, by a close disciple of the author himself is quite in the fitness of things.

The Sanskrit commentary is sufficiently exhaustive, giving explanations of words and discussing their peculiarities by appealing to the Sūtras of Prākrit grammars, especially on the first few verses ; but later on, it almost amounts to a Sanskrit Chāyā with paraphrase here and there. Attention of readers is drawn, now and then, to rhetorical embellishments and metres found in different verses. Even the small portion that we have studied shows that the commentator is a well-read man. He appeals to the authority of Prākrit grammars of Vararuci and Trivikrama and the Prākṛta-mañjarī ; and he quotes from the Kāvya-prakāśa, Bhartṛ-kāvya with the Jayamaṅgalā, Bhāgavata, Raghuvaṁśa, Vaijayantī, etc., and authors like (Amara) Siṁha, Keśava, etc. This Prākrit poem and its commentary are comparatively late compositions; still some of the remarks of the commentator are interesting and deserve special attention.

a—Following the remark of Lakṣmīdhara, Hultzsch and other scholars once arrived at the conclusion, though now exploded, that Trivikrama was the author only of the commentary, the Sūtras being composed by Vālmīki. I have shown elsewhere[7] that Vālmīki-sūtra is a myth and that Trivikrama is the author of both the Sūtras and the Vṛtti. This is now further confirmed by a very explicit statement of our commentator on verse No. 1 :

अत्र त्रैविक्रमे प्राकृतव्याकरणे सूत्रकारेणैव कृतायां वृत्तौ बहुलाधिकारादीषत् स्पृष्टतरविश्रान्तिरपि [—स्पृष्टयश्रुतिरपि १-१-२९] सरिआ, पडिवआ इति सोदाहरणमुक्तत्वादचोर्मध्ये यकारवकारगन्धः प्रयोगसौभाग्यार्थः ।

The value of this remark is duly appreciated, if we remember that our commentator hails from the South and is not a Jaina.

b—In explaining the form *satittha* from *satīrthya* or *satīrtha*, the commentator has offered certain observations[8] which are quite instructive and whose spirit I am reproducing here. First, some Prākrit forms in the dramas do not follow the rules of Prākrit grammars. Secondly, the Prākrit grammars like those of Vararuci and Trivikrama repeatedly appeal to the rule : *bahulam*. Thirdly, it is the usage in literature, based on many an illustration (?), that is to be preferred as authoritative. Fourthly, the Deśyapadas are not fully scrutinised. Fifthly, it is possible that the forms of other dialects might be indiscriminately introduced. Sixthly, some irregularities may be admissible in a Yamaka-kāvya. Lastly, the whole range of grammatic regulation and of usage in literature can be comprehended by God alone. After advancing these reasons the author becomes apologetic and requests the wise to accept

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7 Vālmīki-sūtra : A Myth, *Bhāratīya Vidyā*, II. 2, May 1941.

8 Some of his remarks are not quite clear. I have not given a literal translation but attempted to bring out the spirit of his arguments.

satittha=satīrthya ; and if it is not accepted, he offers *satittha=satīrtha* with a fresh interpretation. The author appears to be aware, rather sub-consciously, of the difficulties facing a student of Prākrit grammatic discipline ; and when he lays special and preferential stress on the usage in literature, we should admit that he is moving along the right line, though he is a bit bewildered by some of the irregularities. To appreciate his reasoning, we have to imagine his mental back-ground : he has in view a perfect and exhaustive system of Sanskrit grammar like that of Pāṇini and the tract of classical Sanskrit which is post-Pāṇinian and which closely follows Pāṇinian system. The relation between the Prākrit grammars and the literature in various Prākrits and from different localities is entirely different : one who looks at them from the Sanskrit point of view is sure to be so much bewildered as to invoke the help of God. The exhaustive and systematic survey of Prākrit attempted by Pischel in his *Grammatik der Prākrit-sprachen* (Strassburg, 1900) has certainly put us on a solid ground ; and now we can very easily appreciate the value of Pischel's methods and results, if we remember the helpless mood of our commentator.

c—Explaining verse No. 1, the commentator remarks thus:

लळयोरविशेषे प्रसिद्धे प्राकृते ळ-कार एव, अत्र प्रयोग एव प्रायः शरणम्।

He admits that *l* and *ḷ* are not different ; still, according to usage, as observed by him in Mss., *ḷ* alone is used in Prākrit. Excepting in the Prākrit portions of some South Indian editions of Sanskrit dramas which are just reprints of Mss., almost as a rule *l* is used in all the editions of Prākrit texts, published in India or outside ; the commentator, however, would expect us to use *ḷ* exclusively. To insist on exclusive usage of *l* or *ḷ* in Prākrit is to ignore the complications of the problem in the wide range of Indo-Āryan.[9] The Ṛgveda preserves *ḷ* and *ḷh* for *ḍ* and *ḍh*. In old Brāhmī Inscriptions, the sign for *ḷ* is available. In the languages of extreme north-west, it appears to be absent ; at least a sign for it is not present in the Kharoṣṭhī script. The old Prākrits found in the fragments of Buddhist dramas do show the change of *ḍ* to *ḷ*. In Pāli the consonant *ḷ* stands for intervocalic *ḍ* and *ḷh* for *ḍh*. The Mss. however constantly interchange *l* and *ḷ*. It appears that very early *ḷ* was given up or at least not distinguished from *l* in writing. In post-Ṛgvedic literature one finds *ḷ* where *ḍ* is expected. Pāṇini knows no *ḷ*. Among the Modern Indo-Āryan languages, Gujarāti, Marāṭhi, Oriyā and Rājasthānī have *ḷ*. Dravidian languages have *ḷ*, at times in more than one form ; and some of them change Sanskrit *l* to *ḷ*.

The position in Prākrits, as it is seen in written records, is uncertain. Prākrit grammars prescribe the change of *ḍ* to *l*; and it is only in Paiśācī that *ḷ* is prescribed. The Devanāgarī Mss. from the North have uniformly *l* ; but the South Indian Mss. in Kannaḍa, Malayālam and Telugu have almost uniformly *ḷ* in Prākrit passages. The Mss. of Trivikrama's grammar do show variations about *l* and *ḷ* according to the

9 I have merely summarised below the general observations from the following sources, especially from Lüders' essay. Pischel : Grammatik der Prākrit-Sprachen, Strassburg, 1900, sections 226, 243, 260, etc.; Geiger: Pāli Literatur und Sprache, Strassburg, 1916, sections 2, 3, 42, 43, etc.; Bloch: La formation de la langue Marathe, Paris, 1920, section 144 ; Lüders : Zür Geschichte, des l im Altindischen in the Antidoron, Festschrift Jacob Wackernagel, Gottingen, 1924, pp 294-308. Those who are interested in details might consult these sources for a connected exposition of the problem and illustrations.

locality and script of the Mss. The modern editors, who have claimed their texts to be critical, have uniformly adopted *l*, even when all the Mss. hailed from the South ; it only means that under the influence of Sanskrit and northern Indian Mss., they are consistently adopting *l* as a matter of editorial discipline.

Linguists like Pischel, Bloch, Lüders and Geiger have approached the problem critically and historically. Lüders concludes his study thus : 'For the post-Vedic period, we must explain *l* as coming from *ḷ* when in Sanskrit or Prākrit a form with *ḍ* occurs beside it or when *ḷ* is proved by old inscriptions or Mss. in Sanskrit and Prākrit or the writing of Pāli.' The change of *ṇ*, *r* and *ḍ* to *l* is not phonetically justified ; we are led to conclude, therefore, that *l* is really speaking cerebral *ḷ* sound, but orthographically represented by *l*. In fact Pischel has emended words like *veṇu*, which according to him, should be *veḷu* in Ardhamāgadhī. For the editor of a Prākrit text, who uses Mss. from South as well as North, the documentary evidence becomes equally balanced with regard to *l* or *ḷ ;* and we have to consider whether we should give up the conventional discipline of exclusively using *l* and begin using *ḷ* in those words where it is linguistically expected.[10]

6. The Prākrit Text : Canto I.

णमह गआणण-पाअं जत्तो विमुहा जणा गआ ण ण पाअं ।
जं णइ-रत्ता ळेहा सळाहणिज्जा अ जत्थ रत्ता ळेहा ॥१॥

10 If there lies any credit in bringing this Prākrit poem to light, the major portion of it should go to my various scholar-friends : Professor Balkrishna Warrier arranged to procure for me the transcript of the Text (first canto, with commentary), both Professor Warrier and Rao Saheb Ullur S. Parameshwar Aiyar, Trivandrum, sent some notes to me about Śrikantha ; Dr. Raghavan, Madras University, gave me important notes that enabled me to distinguish different Śrīkaṇṭhas ; and Sri K. Madhava Sharma, now the Curator of the Anupa Sanskrit Library, Bikaner, sent to me opening extracts of the Madras Ms. Professor H.D. Velankar, Bombay, gave me some important suggestions on the text and commentary. I convey my sincere thanks to all these friends. A modest attempt has been made here to record the available data about the author ; and I hope, other scholars would throw more light on the date of Śrīkaṇṭha, etc.

7. Extracts from the Commentary Re-arranged.

The commentary opens thus: गुरुं गणपतिं वाणीं ब्रह्माणं विष्णुमीश्वरम् । नमस्करोमि लक्ष्मीं च पार्वतीं च मुहुर्मुहुः ॥ श्रीकण्ठरचितं काव्यं तच्छौरिचरिताह्वयम् । व्याचिख्यासे सयमकं प्रौढं प्राकृतभाषया ॥

1 *ab*) गजाननपादं नमत । यस्मात्पादाद्विमुखा जनाः पातं विनिपातं न न गताः, गता एव । व्यतिरेकोक्त्या अन्वयस्य दार्ढ्यमुक्तम् । *cd*) यन्नत्यनुरक्ता आस्तिका लेखाः, देवाः, किं पुनरन्ये इति भावः । पुनरपि तस्य महत्त्वमाह—यत्र च श्लाघनीयाः ध्वजाङ्कुशपद्मादिरूपाः, रक्ताः अरुणाः रेखाः ॥ अत्र त्रैविक्रमे प्राकृतव्याकरणे सूत्रकारेणैव कृतायां वृत्तौ बहुलाधिकारादीषत् स्पृष्टतरविश्रान्तिरपि [स्पृष्टयश्रुतिरपि १-१-२९] सरिआ, पडिवआ इति सोदाहरणमुक्तत्वादचोर्मध्ये यकारवकारगन्धः प्रयोगसौभाग्यार्थः ॥ ळळयोरविशेषे प्रसिद्धेऽपि प्राकृते ळकार एव, अत्र प्रयोग एव प्रायः शरणम् ॥ अत्र यमकं शब्दालङ्कारः । पादान्ते मात्राष्टकं प्रायो यम्यते । अर्थे सत्यर्थभिन्नानां वर्णानां सा पुनःश्रुतिः । यमकं पादतद्भागवृत्ति तद्यात्यनेकताम् ॥ [काव्यप्रकाश, ८३] इति खल्वाहुः । आर्यागीतिश्चेयम् ॥

वंदह मंदारसिअं सरस्सइं इंदु-कुंद-मंदार-सिअं ।
पदिसइ अ कुसग्ग-सिअं पदिवत्तिं सा किइं व अकुसग्ग-सिअं ॥२॥
मंद-रिवुं दावणअं दिइ-णंदणआण वर-ववुं दाव-णअं ।
वंदह वुंदावणअं णंदाणंदं मुणिंद-वुंदावणअं ॥३॥
पणमह परम-सिवाणं पआइ विसआण हाण-परमसिवाणं ।
पुढमा स-अलत्ताणं सवईण अ जे कुणंति सअल-त्ताणं ॥४॥
सरसं भासंताणं विज्जा-विज्जोअ-विणअ-भासंताणं ।
दिअ-दंभा संताणं जाण विहा वहइ सिस्स-भासंताणं ॥५॥
पडिहुण्णामगुरूणं घणा विणा रुद्द-भद्द-णाम-गुरूणं ।
कुणइ कविंमण्णं साअराण सुत्तिम्मि अच्छविं मं णं सा ॥६॥ [जुग्मं]
इह णवर सतित्थाणं सुस्सूसा-विणअ-बद्ध-रस-तित्थाणं ।
मह कअ-परमत्थाणं पणओ मुहलेइ मं खु परमत्थाणं ॥७॥

[2] *a*) मन्देषु अरसिकाम् । *cd*) सा भक्त्या वन्दमानेभ्यो युष्मभ्यं कुशाग्रवच्छितां सूक्ष्मगामिनीं प्रतिपत्तिं प्रतिभां, प्रदिशति च अकुसंगेश्रितां कृतिं वा, वा समुच्चये, कृतिमिवेति वा तामपीत्यर्थः । कुसर्गं कुत्सितं सर्गं श्रिताम् ॥

[3] *a*) मन्दा रिपवो बाधितुमपटवो बाह्या अभ्यन्तराश्च यस्य तम् । बाह्यानां मन्दत्वं किञ्चिद्विवृणोति । दितिनन्दनानां दावनकम्, दूञो ण्यन्तात् कर्तरि ल्युट् । स्वार्थे को वेति ॥ *b*) दावोऽरण्यवह्निस्तस्य नय इव नयः प्रकारो यत्रेति परितापनक्रियाविशेषणम् ॥ *cd*) वृन्दावनगं, नन्दगोपस्य आनन्दम्, तद्धेतुत्वात् श्रीकृष्णम् । मुनीन्द्रवृन्दावनदम्, अवनं रक्षा प्रीणनं वा । चतुरावृत्तियमकम् ॥

[4] *a*) परमशिवयोः पदानि प्रणमत । सुमरह इति वा पाठः ॥ *b*) आशिवानां हानपरम्, इति प्रणमनक्रियाविशेषणम्, सास्तिक्यमित्यर्थः ॥ *cd*) यौ सकलत्राणां सपतीनां च प्रथमौ सकलत्राणं कुरुतः, जगतः पितृत्वात् ॥

[5-6] *a*) सरसं भाषमाणानाम्, सहसं इति वा पाठः, हसो हासः स्मितपूर्वाभिभाषिणामित्यर्थः ॥ *b*) विद्याविद्योतेन विनयेन च भासमानानाम् ॥ *cd*) येषां शान्तानां गुरूणां विधा, अर्थादुपदेशप्रकारः, कीदृशी विधा, दितदम्भा खण्डितव्याजा । वहति आवहति । शिष्यप्रतिभासन्तानम्, शिष्याश्च पार्वतीविष्णुब्रह्मादयः ॥ *ab*) प्रतिभया उन्नामेन गुरूणामलघूनां बहुमानपदानां वा, रुद्र इति भद्रं नाम येषां तेषां गुरूणाम्, सान्द्रा सा घृणा करुणा । *cd*) इमं मां कविंमन्यम् । मां कीदृशं, सूक्त्यां अच्छविं, अपीति शेषः, नञीषदर्थे । सादराणां विद्यासु व्याख्याने शिष्येषु भक्तेषु च सर्वकर्तृकेणादरेण स्वयं सहितानां वा । अत्र रुद्रनामा स्वसहृदयश्च स्फुरति । तत्र गुरुशब्दः औपचारिकः, तद्विशेषणान्यप्यौपचारिकतमानि । निरङ्कुशा हि कवयः ॥

[7] *ab*) इह सतीर्थ्यानां सब्रह्मचारिणां सहृदयानामिति यावत् । शुश्रूषाविनयाभ्यां बद्धस्नेहं तीर्थमुपाध्यायो येषु तेषाम् ॥ *c*) मम संबन्धमात्रे षष्ठी, कृता परमा आस्था यैः । *d*) खु निश्चये, कोऽयं निश्चय इति चेदाह—परं आस्थानम् ।'महाकवयः खलु मुखरताया (:) स्थानं तदास्था

णं सूणं अ-सुरहिअं पडिहा-विहुरं णिबंधणं असु-रहिअं ।
ओ असिव-रसं देहं तंतं व सुमंतिअं अवर-संदेहं ॥८॥
तह वि खलाण सुहत्थं णमिऊण हरिं विसंखलाण सुहत्थं ।
बंधमपाअड-भा-संबंधं बंधेमि पअड-पाअड-भासं ॥९॥
सुणह महाणंदमअं सोरि-चरित्तं खु परमहाणं दमअं ।
किं पि समस्सा-मत्तं जं सुइरो विसअ-विस-समस्सामत्तं ॥१०॥
अह सा बहुला-लसिआ पुहवी खल भर-रुआए बहु-लालसिआ ।
दुहिणं पत्ता रुण्णा णेत्ते रत्तुप्पलग्ग-पत्तारुण्णा ॥११॥
भणइ अ णाहंताणं वरदं भुवणाण साहु णाहं ताणं ।
दुब्भर-भअवंताणं सरणं करुणा जणाण भअवंता णं ॥१२॥

गुरुघृणा च केवलमत्र हेतुरिति भावः ॥ ननु सतित्थाणं इत्यत्र कात्यायनी (कात्यायनी ?) कच्चाअणी इतिवत् त्यथ्यद्यानां चछजा इति चत्वं (छत्वं ?) किं न कृतम् । उच्यते—नाटकादिषु प्राकृतव्याकरणनैरपेक्ष्यदर्शनात् । वाररुच-त्रैविक्रमादिप्राकृतव्याकरणेषु बहुलं बहुलमित्युक्त्या च शास्त्राणां प्रयोगानुसारप्रधानत्वाच्च बहूदाहरणानन्तरमित्यादियुक्तिश्च प्रयोगं प्रमाणयति । यद्वा देश्यपदानां भाषान्तरलक्षणसङ्करस्य चापरिच्छेद्यत्वमत्र निर्वाहः । यमकादिषु च तथाविधो निर्वाहः सह्यते । शास्त्रेषु प्रयोगेषु च सूक्ष्मेक्षिकया सर्वं द्रष्टुमीश्वर एव प्रभवति । तदेतत् सन्तः क्षमन्ताम् । तेऽपि न क्षमन्ते चेत्, सतीर्थानामिति च्छाया । तीर्थं शास्त्रं तेन सह वर्तमानानां मीमांसादिशास्त्रेषु निष्णातानां महतामिति ॥

8 *a*) [असुरभिकं] सूनं ननु, चमत्कारमान्द्यात् तत्तुल्यमित्यर्थः । *b*) प्रतिभादरिद्रं निबन्धनं असुभिः रहितम् । *cd*) ओ उत । अविद्यमानं शिवं मङ्गलं रसश्च यस्य तत् । तन्त्रं वा, तन्त्रमिवेति वा, तन्त्रं राज्यकार्यम्, सुमन्त्रितम्, अवरैरधमैः सन्देहैर्युक्तम् । वा इति चेत् ससन्देहोऽलङ्कारः । इवेति चेत् तस्योपमायाश्च सङ्करः ॥

9 *a*) खलानां सुखार्थम्, परपरिवादे हि तेषां सुखम् । *b*) शुभा आस्था यत्रेति क्रियाविशेषणम्, भक्त्या । *c*) प्रबन्धमप्रकटप्रतिभासंबन्धम् । सूक्ष्मेक्षिकायां प्रायः सुभगमिति विवक्षितमेव । *d*) प्रकटप्राकृतभाषम् ॥

10 *b*) अघानां परं दमकम्, परेषां शत्रूणां महानां उत्सवानां दमकमिति वा । *c*) समस्यामात्रम्, व्याप्तस्य प्रमेयस्य एकवाक्येन संक्षिप्योक्तिः समस्या । वर्ण्यमानमपि संक्षिप्तमिति समस्यामात्रमित्युक्तम् । *d*) सुइरो श्रोता (तृन्), विषयविषशमस्य अमत्रं पात्रम्, शौरिचरितश्रवणशीलानां परमपुरुषार्थः सिध्यतीति भावः ॥

11 *ab*) बहुलाशब्दो गोपर्यायः, गोरूपेण लसिता । खलभररुजया प्राप्तिहेतुत्वेन टा ॥ *cd*) द्रुहिणं ब्रह्माणम् । रक्तोत्पलाग्र्यपत्रस्यारुण्यमिवारुण्यं यस्याः, रोदनं चास्य हेतुः ॥

12 *a*) नाथमानानां याचमानानाम् । *b*) साधु इति वरदानक्रियाविशेषणम्, हु इति पृथक्पदं वा । *cd*) दुष्टो भरो दुर्भरः, ततो यद्भयं तद्वताम्, जनानां अस्मदादीनाम् । भयवताम्, लोकगुरुत्वाद् बहुवचनम्, भयवत इत्येवार्थः ॥ अतस्तदवस्थां मां दुष्टदैत्यभारहरणेन रक्ष इत्युक्तं भवति । विशेषे प्रस्तुते सामान्याभिधानादप्रस्तुतप्रशंसाप्रकारोऽयम् ॥

भुवणुंभ-णिआणेणं धरा हरी भर-हरो त्ति भणिआ णेणं ।
इअ किर सा सुरस-हिअं सुणिऊण गिरं गआ रसा सुर-सहिअं ॥१३॥

अवण-विहाण-मणं तो जआण जणिओ हि सावहाणमणंतो ।
अरि-वण-वसु-देवेणं फुरइ बलो रोहिणीए वसुदेवेणं ॥१४॥

खलिअ-खलं खण-लक्खं पोक्खर-णअणं फुरंत-लक्खण-लक्खं ।
पसवइ मुक्खं तणअं पढम-वहू से विवक्ख-मुक्खंत-णअं ॥१५॥

अह सो वअ-महिआणं वसओ वसुदेव-विहिअ-वअ-महि-आणं ।
सुहिअ-जसोआणंदं वड्ढइ वड्ढंत-सुर-विसोआणंदं ॥१६॥

दणुआणं दवहू जा णेण णिआ देवइं पि णंद-वहूजा ।
तज्जिअ-कंसाआसं गआ ण भत्ताण धुणइ कं साआसं ॥१७॥

ताए सुअ-वुत्तंतो भोअवई जो णिसग्ग-सुअ-वुत्तंतो ।
स-घिणं जंपइ वअणं स-विलिअमालोइऊण जंपइ-वअणं ॥१८॥

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13 *a*) भुवनानामुम्भः संदृब्धिः सृष्टिरिति यावत् । तस्य निदानेन, निदानं त्वादिकारणम् । निमित्तकारणं हि ब्रह्मा दक्षादीनामपि स्रष्टृत्वेन तस्यादित्वम् ॥ *b*) हरिर्भरहर इति द्रुहिणेन धरा भणिता ॥ *c*) सुरसां हितां च गिरं वाचम् । *d*) सा रसा सुरैः सहितं यथा भवति (तथा) ॥

14 *ab*) अवनविधाने मनो यथा भवति तथा इति स्फुरणक्रियाविशेषणम् । जआण जगताम्, अवनेन संबन्धः । सावधानम्, गर्भाधानेतिकर्तव्यतामनुलङ्घयेत्यर्थः ॥ *cd*) अरय आभ्यन्तरा बाह्याश्च, तद्रूपस्य वनस्य वसुना अग्निदेवेन । फुरइ अस्फुरत् ॥

15 *ab*) स्खलितः विहतेच्छः खलः पापी कंसो येन तादृशम् । क्षणकालवर्ति लक्षं व्याजो यस्य तम् । क्षणं तद्दर्शनोद्यतम् । पुष्करनयनं, श्रीपुण्डरीकाक्षम् । स्फुरद्भिर्लक्षणैः स्वचिह्नैः शङ्खचक्रादिभिर्लक्ष्यम्, विष्णुरिति मातापितृभ्यां ज्ञातव्यम् ॥ *cd*) पसवइ प्रासूत मुख्यं तनयम् । प्रथमवधूः, वसुदेवस्य देवकी नाम । विपक्षभूता ये मूर्खाः कृत्याकृत्यमूढाः, तेषामन्तो नयो यस्य तं तनयम् ॥

16 *ab*) स व्रतमहितानां वशगः । वसुदेवेन विहितं व्रजमहीयानं यत्रेति वर्धनक्रिया-विशेषणम् । वसुदेवेन व्रजं नीत इत्यर्थः ॥ *cd*) सुखितौ यशोदानन्दौ यत्र तदपि क्रियाविशेषणम् । वर्धमानः सुराणां विशोको दुःखशाबल्यरहितः आनन्दो यत्र तदपि क्रियाविशेषणम् । वड्ढइ एवमेवं च अवर्धत ॥

17 *ab*) दनुजानां दवथुः सती तेन वसुदेवेन नीता । देवकीमपि, तस्याः पुत्रो यशोदां नीतः, तत्पुत्रिकामपि, इत्यपि-शब्दार्थः ॥ *cd*) तर्जितकंसा आकाशं गता । सा भक्तानां कं आयासं न धुनातीत्यर्थः ॥

18 *ab*) श्रुतवृत्तान्तः, किं मया हतयेत्यादि । यः भोजपतिः, निसर्गेण स्वतः, श्रुतवृत्तयः श्रुतं शास्त्रं वृत्तमाचारः तयोरन्तः धर्म्यपथनाशक इत्यर्थः ॥ *cd*) आलोक्य जंपइ-वअणं दम्पत्योर्वच[द ?] नम् ॥

मरिसह सुअ-णासं तं मणं भरंता महम्मि सुअणा संतं ।
णं परम-विआरेहिं मरिसिज्जइ सअण-खलिअमविआरेहिं ॥१९॥
णिअ-कम्म-वराहीणं जगं पि जं णेण णाहमवराही णं ।
जइ णाम सहावत्थं तं वि समत्थं सुहं व असहावत्थं ॥२०॥
तस्स किवा णंदेइ च्छला ण दे जो गले किवाणं देइ ।
चलइ खु णीआण मअं खणे खणे रअ-भरेण णीआण मअं ॥२१॥
अह अ अमच्चाण सअं आदिसइ खलाण सेअमच्चाण सअं ।
हम्मह सावअ-सत्थं दिट्ठि-गअं इसि-अणं पि सावअ-सत्थं ॥२२॥
छिंदह जाअं जाअं छंदसिअं छंदसाण जाअं जाअं ।
ताण अ जाअं जाअं बंधह रुंभह सुराण जाअं जाअं ॥२३॥
इअ सो बाल-वहत्थो भोअवई भणइ अहह बाल-वहत्थो ।
सो धम्मो हसिआणं सुअणेहि तम-प्पहुत्त-मोह-सिआणं ॥२४॥
आसि अ सुद्धंतरओ कअ-कज्जो जो ण जाउ सुद्धंतरओ ।
गोट्ठं धेणुअ-सबलं फस-वुंदं पत्थिअं च धेणुअ-स-बलं ॥२५॥

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19 *ab*) मणं संतं भरंता तं सुअणासं मरिसह इत्यन्वयः । मणं भरंता महम्मि मनः बिभ्राणौ मयि । सुजनौ युवाम्, सुअणा इति संबोधनं वा ॥ *cd*) ननु परमविचारैः मृष्यते स्वजनस्खलितमविकारैः ॥

20 *ab*) जगदपि, न परं युवां, अहं ते शिशवश्च । निजकर्मपराधीनम् । *cd*) यदि नाम स्वभावस्थम्, तदपि समस्तं सुखं वा [असह्यावस्थम्], असह्यावस्था यत्रेति द्वयं स्थितिक्रियाविशेषणम् ॥ समस्तं वस्तु सुखं वा असहावस्थं वा यथा भवति तथा स्वभावस्थं यदि नाम तथापि नाहमपराधी इति ॥

21 *ab*) तस्य कंसस्य । छलात्, छलशब्देनास्थिरत्वं लक्ष्यते । दे तौ, ण णंदेइ न अनन्दयत् । कृपाणं खड्गम् अदात् । *cd*) नीचानां मतं चिन्तितं इष्टं वा । क्षणे क्षणे रजोभरेण मदं नीतानाम् ॥

22 *ab*) अमात्यानां प्रलम्बादीनां शतं संहतिं स्वयं आदिशति स्म । कीदृशानां, खलानां सैकमत्यानाम् ॥ *cd*) दृष्टिगतं शावकानां सार्थम्, ऋषिजनमपि, शापकेन कुत्सितेन शापेन सार्थं सधनम् ॥

23 *ab*) छान्दसानां [श्रोत्रियाणाम्], [छन्दश्रितम्] छन्देनाभिप्रायेण श्रितम् । छन्दःशब्दो वेदपर्यायो वा । छन्दःश्रितमिति द्वितीयातत्पुरुषः । जातं जातं यागं यागम् ॥ *cd*) तेषां च छान्दसानां जायां जायां बध्नीत । सुराणां जातं जातं समूहं समूहं रुन्ध ॥

24 *ab*) इति स बालानामज्ञानां पथि स्थितः । अहह इत्यद्भुते खेदे वा । बालानां शिशूनां वधे आस्था यस्येति बालवधास्थः ॥ *cd*) हसितानां सुजनैः, तमःप्रभुतमोहश्रितानाम् ॥

25 *ab*) शुद्धान्तरतः, अन्तःपुरे रतः । न जातु [शुद्धान्तरकः], शुद्धमान्तरं मनो यस्य सः, स्वार्थे कः ॥ *cd*) गोष्ठं धेनुकशबलम्, स्पशानां चाराणां वृन्दं प्रस्थितं च धेनुकेन सबलं शक्तिमत् ॥

पवरो पूअ-णआणं पहू पुलोएइ ललिअ-पूअण-आणं ।
जोअं लक्ख-सिआए संभरइ स-लक्खणाण लक्खसिआए ॥२६॥
णिअ-अप्पाणंतेणं पहुणा विहुएण से अ पाणंतेणं ।
गअ-कंपाणंतेणं पसहं कीरइ थणाण पाणं तेणं ॥२७॥
जस्स हि पीअं वसणं तेण थणेणब्भआण पीअं वसणं ।
मुच्छइ मइरा-मोओ जो सो सइ से सवे वि मइरामोओ ॥२८॥
सो सअढाआरेण च्छलिउं दणुएण धुअ-दिढाआरेण ।
पत्तो; सो मोक्ख-गओ पुणो विबंधो अ परवसो मोक्ख-गओ ॥२९॥
रअ-बहुणा वट्टंतं वचाऽरूवेण सो तणावट्टं तं ।
हिंसइ आआस-अरं कंठे गहिअं महिम्मि आआसअरं ॥३०॥
रअ-रुइरंगं ताणं घेत्तूण व अंगणम्मि रंगंताणं ।
चुंबइ माआ महिआ बल-कण्हाणं मुहाइ माआ-महिआ ॥३१॥
वंस-जसोआऽणूणं जा उवगूहइ हरिं जसोआ णूणं ।
सा वि स-मोक्खा णंदासु-समा णिंदिअ-सु-मुक्ख-मोक्खाणंदा ॥३२॥

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26 *ab*) पूतनयानां पूतः अपनयानुपहतः नयो येषां तेषाम् । प्रभुः कृष्णः । पुलोएइ अपश्यत् । ललितायाः पूतनायाः यानं स्वसमीपगमनम् ॥ *cd*) योगम् , लक्षं व्याजं श्रितया । संस्मृतवान् । स्वस्य लक्ष्मणस्य च द्वयोः । राक्षस्या, रलळानामविशेषः ॥

27 *ab*) निजतल्पमनन्तो यस्य तेन प्रभुणा । विधुतेन तस्याश्च प्राणान्तेन ॥ *cd*) गतकम्पश्वासावन्तरहितश्च तेन प्रसभं अक्रियत ॥

28 *ab*) यः साक्षात् पीताम्बरो विष्णुरित्यर्थः । अर्भकाणां व्यसनं पीतम् , तया कृतं व्यसनमपि शमितमित्यर्थः ॥ *cd*) तस्याः सदा मदिरायामाभीक्ष्ण्येन मोदः, शवेऽपि मदिरः सर्वजनहर्षजनकः आमोदः गन्धः मूर्छति स्मेति शेषः ॥

29 *ab*) शकटाकारेण व्याजं कर्तुं दनुजेन, धुता दृढाचारा धार्मिका येन तेन, स प्राप्तः अभूदिति शेषः । *cd*) स दनुजः, मौर्ख्यं मौढ्यं गदो व्याधिर्यस्य सः । पुनः विश्लिष्टबन्धश्च, चरणाग्रव्याघातेनास्तव्यस्ताङ्गप्रत्यङ्गः । परवशः मोक्षं गतः । अहो महिमा भगवत्पादस्पर्शस्येति भावः, पुनरुक्तवदाभासोऽलङ्कारः ॥

30 *ab*) रयेण बहुना प्रभूतेन । वात्यारूपेण वर्तमानम् । तृणावर्तं नामासुरम् । *cd*) आकाशचरं कण्ठे गृहीतम् , मह्यां आयासकरम् ॥

31 *ab*) करीषरजोरुचिरमङ्गम् । *cd*) महिता माता चुंबइ अचुम्बत् । मायामथिता वशीकृता मोहितेति यावत् ॥

32 *ab*) मातृपितृपतिवंशानां यशोदायिनी, अनूनम् । *cd*) सापि समौर्ख्या नन्दस्य प्राणसमा निन्दितः सुतरां मुख्यः मोक्षानन्दो यया सा तथा, अभूदिति शेषः । समौर्ख्यापत्यिन्वयः ॥

दणुउण्णामंताणं गग्गो पच्चग्गएइ णामं ताणं ।
जाण अ णाम-सहस्सं इसि-वुंदं स-हरिस-प्पणाम-सहस्सं ॥३३॥
एक्कं बलभद्दं तं अण्णं कण्हं खलाण बल-भद्दंतं ।
गग्गो साअर-हसिओ भणिऊण गओ अ स-प्पसाअ-रह-सिओ ॥३४॥
वअ-पअ-जंबाल-अरा रुवंति दे सो रसो खु जं बालअरा ।
गोवि-अणा विहसंता होंति घरे विरअ-विरअणा-विह-संता ॥३५॥
स-हरिसमाहीराणं खणो व्व कालो गओ खमा-हीराणं ।
ताण अ पुच्छंताणं मिह-चरिअं गहिअ-वच्छ-पुच्छंताणं ॥३६॥
सो सरसं वच्छ-रओ णंद-सुओ गमिअ-सत्त-संवच्छरओ ।
सोहइ सामो स-णओ दणुआसु-दहीण अंजसा मोसणओ ॥३७॥
जो णिच्चो राअंतो रमावई सो वि गव्व-चोराअंतो ।
वअ-वहु-बद्धो संतो सद्दो व्व ठिइ-च्चुओ अबद्धो संतो ॥३८॥
जो समिअज्जुण-भंगो होइ विहू सो अहो कअज्जुण-भंगो ।
ताण अ साणुग्गहणं हरिणो केलास-सेल-साणु-ग्गहणं ॥३९॥

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33 *ab*) दनुजोन्नामान्तयोः गर्गः प्रत्यग्रं करोति स्म नाम तयोः । *cd*) ययोश्च नामसहस्रं, अस्तीति शेषः । ऋषिवृन्दं सहर्षप्रणामसहस्रम् ॥

34 *ab*) खलानां बलस्य भद्रस्य चान्तम् । *cd*) गर्गः सादरहसितः भणित्वा, अनेन नामकरणमुक्तम् । गतश्च सप्रसादं रहः श्रितः ॥

35 *ab*) व्रजपदे व्रजस्थाने, जम्बालः पङ्कः, तत्र चरन्तौ रिङ्खन्तौ । स रसः तयोस्तत्कालोचितसुखानुभवः, रोदनं च तदा तादृशप्रायम् । खु संभावने, यद् बालतरौ ॥ *cd*) गोपीजनाः, विरता विरचनाविधाः सेकः संमार्जनादिप्रकारा येषां ते, चामी शान्ताश्च क्रियाविशेषणसमासो वा ॥

36 *ab*) सहर्षमाभीराणाम् । क्षमाया भूमेः, हीरयो रत्नयोः । *cd*) तयोः मिथः चरितं प्रवृत्तिं पृच्छताम् । गृहितवत्सपुच्छान्तयोः ॥

37 *ab*) वत्सरतः गोवत्सपालकः नन्दसुतः । *cd*) श्यामः सनयः, दनुजासूनां दघ्नश्च अञ्जसा मोषणकः । सनयत्वं मोषणेषु ॥

38 *ab*) यो नित्यो राजन्, गव्येषु क्षीरादिषु चोरायमाणः । *cd*) व्रजवध्वा यशोदया उलूखले बद्धः । तदानीं शान्त इव भवन् । शब्द इव स्थितेर्मर्यादायाश्च्युतः अबद्धः सन् । अबद्धं स्यादनर्थकम् । स्थितिच्युत्यैव साधर्म्यम् । शान्त इति विधेयं चेत् शान्त्यापि ॥

39 *ab*) शमितः पश्चादर्जुनस्य पार्थस्य भङ्गः पराजयो येन । कृतः अर्जुनयोः ककुभयोः भङ्गः आमर्दनं येन तादृशोऽभूत् । विरोधाभासेन अहो इत्युक्तम् । *cd*) तयोश्च नलकूबरमणिग्रीवयोर्नारदशापाद्यमलार्जुनीभूतयोः तदा शापान्मुक्तयोः । हरेः अनुग्रहणेन सह वर्तमानं यथा भवति तथा । कैलासशैलसानुनो ग्रहणं प्राप्तिः । चकारेण अभूदिति समुच्चीयते ॥

गुरु-कारुण्णं वअणं घेत्तूण सुअं पि से परुण्णं वअणं ।
चुंबइ सहसा णंदो उप्फुसइ स-सेअ-बिंदु स-हसाणंदो ॥४०॥
तं साणंदो णंदो सिस्सइ सेवंति जं सणंदा णंदा ।
सअणे छंदं छंदं देइ खु जो जं पि थुवइ छंदं छंदं ॥४१॥
अह वुंदावण-गमणं गोव-अणो कुणइ स-तिण-दाव-णग-मणं ।
तं वणमावण्णाणं फुरइ रसो सिं व सुअणमावण्णाणं ॥४२॥
जत्थ हि सहआराणं वणे रुई कोइलाण सह-आराणं ।
चल-चक्खुब्भंताणं जत्थ हरीणं ठिई ण खुब्भंताणं ॥४३॥
लसइ जहिं तालाणं णिउरुंबं सोंबरं व हिंतालाणं ।
जत्थ असोआलीणं साणो सूणेसु वा असोआलीणं ॥४४॥
तह पिक्कं पणसाणं काअं वि उलूअ-हिअअ-कंपण-साणं ।
जत्थ अ पत्त-रहाणं अत्थि रसो सइ सवहु-पत्त-रहाणं ॥४५॥
जत्थ विसाल-वणाणं सराण सारा सिरी वि[=र]सालवणाणं ।
तीर-रसाल-वणाणं भमर-रुईहिं सिरीए सालवणा णं ॥४६॥

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[40] *ab*) गुरुकारुण्यम्, ग्रहणक्रियाविशेषणं वचनविशेषणं वा । वचनं गृहीत्वा उक्त्वेत्यर्थः । सुतमपि गृहीत्वेति समुच्चीयते । तस्य प्ररुदितं वदनम् । *cd*) सस्वेदबिन्दु । हसो हासः स चानन्दश्च ताभ्यां सह वर्तमानः ॥

[41] *b*) सनन्दः नन्दश्च, स्वपार्षदौ । *cd*) स्वजने अभिप्रायमभिप्रायम्, इष्टमिष्टम् । स्तौति छन्दश्छन्दः ॥

[42] *b*) सतृणे दावे वने नगे गोवर्धने च मनो यथा भवति तथा । *cd*) तं वनमापन्नानां प्राप्तानाम् । सिं तेषां । सुजनमापद्गतानाम् यथा रसः स्फुरति तथेति ॥

[43] *ab*) जत्थ अ यत्र च, सहकाराणां रुतिः रुचिर्वा । कोकिलानां सहदाराणाम् । *cd*) चलच्चक्षुषां तथा उद्भ्रान्तानां हरीणां सिंहानाम् । क्षुभ्यताम् ॥

[44] *b*) सोंबरं सोदुम्बरम् । हिन्तालानामिव, तेषामपीत्यर्थः । *cd*) अशोकालीनां स्वानः सूनेषु वा अविद्यमानशोकानामलीनाम् । वाशब्दो वाक्यार्थसमुच्चये ॥

[45] *ab*) पक्वं फलमित्यर्थात्, पनसानां यत्रास्तीत्यनुषङ्गात् । काकं काकसमूहः । उलूक-हृदयकम्पनस्थानम् । काकानामुलूकानां च जातिसिद्धं वैरम् । *cd*) पत्त्ररथानां मयूरादीनाम् । आसि इति वा पाठः । सवधुप्राप्तरहसाम् । जनानामपि इति ॥

[46] *ab*) विशालं वनं जलं येषु तेषां सरसाम् । रसस्यालवनमखण्डनं येषु तेषाम् (?) । *cd*) तीरे रसालानामाम्राणां वनानाम् । भ्रमररुतिभिः श्रिया सालपना ननु । यत्र सरसां श्रीः तीररसालवनानां श्रिया सह सालपनेव उभयत्र भ्रमररुतीनां संभवात् ॥

तह भिसिणी-वाराणं समिद्धी अस्समेव्व णीवाराणं ।
जत्थ अ सारावरआ सरिआ समणस्स सरइ साराव-रआ ॥४७॥
जा पंकालिं दीणं [आसंजंताण] कुणइ कालिंदी णं ।
कोकअ-भूरि-विभंगा वेणि व्व वसुंधराए भूरि-विभंगा ॥४८॥
पेच्छइ वच्छाआरं रिउं हरी अत्तणो अवच्छा-आरं ।
तं [सो] सरणं ण गओ गओ अ खित्तो [इमेण सरणं ण]गओ ॥४९॥
बाहइ गोत्ताआरं बआसुरं सो खु विहअ-गोत्ता-आरं ।
जो से अणलस-माणो तोंडअ-दंडे वि आसि अणल-समाणो ॥५०॥
कअ-वअ-वाह-सहावं मारेइ महासुरं स-वाहस-हावं ।
इअ सइ दिइ-सुअ-णासं चिणइ चिरंतण-सिसू अदिइ-सुअणासं ॥५१॥
बालअ-कीला-लसिआ कालिंदि जा खु असिअ-कीलाल-सिआ ।
ईसा घोसावासा समहिगआ जा स-भंग-घोसावासा ॥५२॥
जाए विसममअमहो मलिणं विमलं वि एस विसम-मअ-महो ।
रइणो सा तणआ णं भाणं सिसिरत्तणाण सात-णआणं ॥५३॥

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47 *ab*) बिसिन्याम्भः वाराः समूहाः तेषाम् । आश्रमे इव नीवाराणाम् । *cd*) सारा उत्कृष्टा अवरजा । शमनस्य यमस्य सरति प्रवहति, सारावो रयो यस्याः सा ॥

48 *ab*) पङ्कानां पापानामालिम् । समासजतामवगाहमानानाम् । *cd*) कोककश्च .....तदाख्या भूरयो बहवो वयः पक्षिणो येषु तथाविधा भङ्गास्तरङ्गा यस्याः सा । भूरि [स्वर्ण], तन्मया विभङ्गाः केशाभरणविशेषा यस्याः ॥

49 *ab*) वत्साकारं रिपुम् । आत्मनः अपथ्याचारम् । *d*) गतश्च क्षिप्तः इमेण अनेन, सरणं शरणं, विशीर्णदेवत्वम् । णगओ नगगः (तः) (?) ॥

50 *ab*) वाहइ अबाधत हतवान् । गोत्रः पर्वतः तस्येव महानाकारो यस्य तम् । विहतः गोत्राया गोसमूहस्य [चारः] येन तम् । *cd*) अमन्दचित्तसमुन्नतिः तुण्डदण्डेऽपि आसीत् अग्नितुल्यः ॥

51 *ab*) कृतव्रजबाधस्वभावम् । वाहसस्याजगरस्य भावस्तत्त्वं तेन सह वर्तमानम् । *cd*) दितिसुतनाशम् । अविद्यमाना दितिः खण्डनं यस्याः ताम् (?)........॥

52 *ab*) बालकक्रीडालसितौ । या खलु असितेन कीलालेन जलेन श्रिता, द्वितीयासमासो वा । *cd*) ईशौ, घोषे आवासो ययोः तौ समभिगतौ । भङ्गानां तरङ्गाणां घोषेण सह वर्तमाना च ॥

53 *ab*) यस्याः विषं जलं अमृतं, तत्तुल्यमित्यर्थः । अहो अथो । मलिनं कृष्णम् । विषम-स्वरूपः उत्सवः । *cd*) रवेः सा तनया ननु भाजनम् । शिशिरत्वानां सातं सुखं तस्य नयानां प्रापकाणाम् ॥

हरिसइ जउणा हसिआ हर-सिर-सरिआए ज व्व जउणाह-सिआ ।
संसइ हंस-रुईहिं हरिं व मउलंजली-सहं स-रुईहिं ॥५४॥
कअ-रिउ-चक्काअसणो अणुकअ-पिअ-केइ-काअ-चक्काअ-सणो ।
सर-सिअ-सारंगाणं अणुरोइ रुअं रएइ सारं गाणं ॥५५॥
चुअ-संकं साराई-सण्ण-हिरण्णक्खओ खु कंसाराई ।
मउलंगो बालेहिं कीलइ कीलालअम्मि गो-वालेहिं॥५६॥
सलिल-सवण्णाआरो ण मुणिज्जइ झत्ति लद्ध-वण्णाआरो ।
अह तं अण्णेसंता वेदा विअ बालआ अ अण्णे संता ॥५७॥
उवगूहइ वाहाहिं वीईहि व विहिअ-कलुस-हइ-वाहाहिं ।
जउणा तं ण्हाण-रअं पविहंडिअ-भत्त-भोअ-तण्हा-णरअं ॥५८॥
अह सो कालिअमहिअं काऊण जलं सुहेइ कालिअमहिअं ।
उज्झिअ-रमणअ-साआ णाईण थुई वि लद्ध-रमणअ-साआ ॥५९॥
पमाणिआ पमा णिआ मुणीहि जस्स दंसणे ।
वअं गओ व अंगओ वहूण सो सिरीहरो ॥६०॥

। इअ सोरिचरित्ते पुढमो आसासो ।

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54 *b*) हरशिरःसरिता । या इव । यदुनाथं श्रिता । सा हरगता अहं विष्णुं श्रितेति हर्षहेतुः । *cd*) हंसरुतिभिः । मुकुलाञ्जलिसखम्, तेन सहेत्यर्थः । सरुचिभिः सशोभाभिः ॥

55 *ab*) कृतं रिपूणां चक्रस्य समूहस्य आयसनं क्लेशः येन सः । अनुकृतपिककेकिकाकचक्रवाकस्वनः । *cd*) सरःश्रितसारङ्गाणां भृङ्गाणाम् । रएइ अरचयत् ॥

56 *ab*) च्युतशङ्कं साराजिसन्नहिरण्याक्षः । *cd*) मृदुलाङ्गो बालैः अक्रीडत् ॥

57 *ab*) सलिलसवर्णाकारः, स इति शेषः । लब्धवर्णो विचक्षणः तस्याचारो यस्य । सअलवण्णाआरो सकलवर्णाचार इति वा । *cd*) बालकाश्च अन्ये श्रान्ताः ॥

58 *ab*) वीचीभिरिव । वीचिभिर्वाहाभिरुपागूहदित्यन्वयः । विहिता कलुषैः पापैः या हतिरपकर्षः लोकस्य तस्याबाधा याभिः । स्नानरतं प्रविखण्डितभक्तभोगतृष्णानरकम् ।

59 *ab*) कालियेन नागेन मथितम्, विषदूषितमित्यर्थः । जलम्, तस्या इति शेषः । सुहेइ शुभमकरोत् सुखं वा । कालितम् अहितम् अरिम्, अर्थात् कालियम् । *cd*) उज्झितस्त्याजितो रमणकस्य भर्तुः सादो यया सा । नागीनां स्तुतिरपि, लब्धं रमणकाख्ये द्वीपे सातं सुखं यया तादृशी अभूदिति शेषः । विरोधाभासः ॥

60 *ab*) प्रमानिता प्रकर्षेण मानिता । प्रमा प्रमाणम् । निजा, नित्या वेदा इत्यर्थः । प्रमाणिकावृत्तमिति च स्फुरति । वअं गओ, व्रजं गतः । अपवाहितकालियकालिन्दीजलादुत्तीर्य तत्रैव तां निशां सबन्धुरुषित्वा प्रातरिति शेषः । व, इव । अंगओ अंगजः । वधूनाम् अङ्गज इवेत्यन्वयः । सिरीहरो श्रीधरः ॥

SOME AUTHORS OF THE ĀRḌE FAMILY

And Their Chronology — Between A. D. 1600 and 1825

By

P. K. GODE, M.A.,

Curator, Bhandarkar Oriental Research Institute, Poona

HALL[1] in his *Bibliography* refers to Mss of the works of a writer on logic by name "Kṛṣṇabhaṭ Ārḍe" but indicates no chronology for them. Dr. Satischandra Vidyabhusana in his *History of Indian Logic*[2] refers to this author as Kṛṣṇabhaṭṭa Āḍe and states that he died about 150 years ago. If the statement made by Vidyabhusana is correct we shall have to suppose that Kṛṣṇabhaṭṭa Ārḍe (not Āḍe) died about *A.D. 1771*. This statement, however, seems to be wrong as will be seen from the evidence to be recorded in this paper, which shows that this author was living at Benares thirty years after the probable date of his death mentioned by Vidyabhusana, who unfortunately records no evidence for his surmise.

Aufrecht records about 74 works of this author. In CC II, 23 and CC III, 26 Aufrecht calls him son of Raṅganātha. In CC III, 114 he informs us that one रङ्गनाथ आरड son of महादेव wrote दशकुमारचरितपूर्वपीठिकासार (Stein 81). Hall in his edition of the *Vāsavadattā* (*Bib. Ind.* 1859) states that a rumour had reached him regarding a commentary on the *Vāsavadattā* by Kṛṣṇabhaṭṭa Ārḍe but Aufrecht makes no mention of this com-

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1 *Index to the Bibliography of the Indian Philosophical Systems* by Fitzedward Hall, Calcutta, 1859, pp. 31, 35, 37, 56, 59.

p. 31—गदाधरीविवृत्ति and कृष्णभट्टी by Kṛṣṇabhaṭṭa Arḍe, son of Raṅganātha, and pupil of one Hari. The Author was a Marahatta Brahmin of Benares. He had an elder brother Nārāyaṇa. He wrote a commentary on the निर्णयसिन्धु.

p. 35—जगदीशतोषिणी a commentary by Kṛṣṇabhaṭṭa Arḍe (=*KA*)

p. 37—सिद्धान्तलक्षणक्रोड by KA.

p. 56—शाक्तिवादविवरण by KA, son of Nārāyaṇa Bhaṭṭa, son of Raṅganātha Bhaṭṭa,

p. 59—आख्यातवाद टिप्पणी by KA.

2 *Vide* p. 486 of Calcutta Edition, 1921 : "Kṛsnahaṭṭa Āḍe was a Marathā, who wrote a gloss on Gadādharī called *Gadādharī Kāśikā* and one on Śiromaṇi's *Tattva—Cintāmaṇi* while residing at Benares where he died about 150 years ago. The gloss has been printed in Telugu characters". Kṛṣṇabhaṭṭa begins his Kāśikā thus—

श्रीकृष्णं मुहुरानम्य कृष्णो नारायणानुजः ।
गदाधरमतार्थानां टिप्पणीं तनुतेऽद्भुताम् ॥
राङ्गनाथी कृष्णशर्मा पण्डितेभ्यः कृताञ्जलिः ।
याचते भूय आनम्य दूष्यं बुद्ध्वा वन्नो मम ॥"

mentary. Hall further informs us in foot-note 1 on p. 47 of his Preface to Vāsavadattā as follows :—Kṛṣṇabhaṭṭa was "a Maratha of Benares ; son of Raṅganātha and pupil of one Hari. Among his works are huge commentaries on the निर्णयसिन्धु, गदाधरी and जगदीशी. The second is called काशिका or गदाधरीविवृत्ति; and the third मञ्जूषा or जगदीशतोषिणी. The गदाधरी is by गदाधरभट्टाचार्य. The जगदीशी by जगदीशतर्कालंकारभट्टाचार्य. They annotated respectively the whole and a part of the दीधिति of रघुनाथशिरोमणिभट्टाचार्य which consists of notes on the first two Sections of Gaṅgeśa Upādhyāya's तत्त्वचिंतामणि, a celebrated treatise of Nyāya philosophy."

M. M. Professor P. V. Kane makes the following remarks regarding the above author but indicates no chronology for his works :—

> "Comm. (on निर्णयसिन्धु A.D. 1612) रत्नमाला or दीपिका by कृष्णभट्ट आर्डे." [1]
>
> "कृष्णभट्ट आर्डे (or आरड), son of रघुनाथ of Benares ; Author of रत्नमाला alias दीपिका on निर्णयसिन्धु of कमलाकरभट्ट." [2]

The foregoing remarks of several scholars like *Hall*, *Aufrecht*, *Kane*, reveal that Kṛṣṇabhaṭṭa Ārḍe was not only a great logician but also a learned commentator on works pertaining to *dharmaśāstra* and *Kāvya*. Though I have not before me any Mss. of the several works of this author I shall record in this paper some contemporary evidence which conclusively proves the chronology of this author.

The India Office Library Catalogue[3] contains a description of 11 fragments of the *Kāśikā* of Kṛṣṇabhaṭṭa Ārḍe. This description is concluded with the remarks :—"Date of this part (11th) संवत् १८५७ मिति चइतवदी १२ वारसनीचर. All parts were written about the same time." These remarks show that the above fragments were copied in Saṁvat 1857=*A. D. 1801*. Elsewhere[4] in this Catalogue Mss. of अनुमानमञ्जूषा on the जगदीशी by this author are described but this description contains no dates of the Mss.

I was under the impression that Kṛṣṇabhaṭṭa Ārḍe was a Deśastha Mahārāṣṭra Brahmin. My friend Mr. Raghunātha Shastri Patankar of Rajapur informed me, however, that there is a family of Karhāḍā Brah-

1 *Vide* p. 574 of *Hist. of Dharma-Śāstra*, Vol. I, 1930 (B.O.R.I.).

2 *Ibid*, p. 687.—*Vide* Aufrecht, *CC I*, 298- निर्णयसिन्धु Comm. by कृष्णभट्ट आर्डे. "Hall, p. 31, K. 182, B. 3. 100, Burnell, 1306, Lahore, 10, Oppert II, 8045 (Kṛṣṇa Śrama)."

3 Part IV (Philosophy and Tantra Mss) by Windisch and Eggeling, 1894, pp. 618-619.

4 *Ibid*, p. 625-627—Mss Nos. 1922, 1923.—Vol. I has the following couplets after the Colophon—

" अक्षपादमतार्थानां काशिका मुक्तिकाशिका ।
यथा त्यक्तशरीराणां काशिका मुक्तिकाशिका ॥१॥
हरिः पिता हरिर्माता हरिर्भ्राता हरिः सुहृत् ।
हरिरेव जगत्सर्वं हरेरन्न्यन्नभाति मे ॥२॥"

Colophon of Vol. II reads—

"इत्यारडोपाह्वकृष्णभट्टविरचिता चतुर्दशलक्षणीमञ्जूषा ॥"

mins[1] of the name "Ārḍe" now residing in the Rajapur Taluka of the Ratnagiri District and that he is in touch with the present members of this family. I have requested him to send me a genealogy of this family to enable me to see if our Kṛṣṇabhatta Ārḍe, the logician, belonged to this family originally and then migrated to Benares for his education.

The following evidence shows that Kṛṣṇabhaṭṭa Ārḍe was living at Benares about *A.D. 1801-02*, the date of the India Office Ms. of his work referred to above.

In a Marathi Magazine[2] containing materials for the history of the Kāyastha Prabhus the history of a caste-dispute during the time of Peshwa Bajirao II is recorded. In this account of the dispute[3] a letter from Benares Pandits is reproduced. It is addressed to the Poona Brahmins, and is signed by about 81 Brahmins of Benares grouped as follows :—

40—Mahārāṣṭra Brahmins ———	संमतोयमर्थः	(महाराष्ट्रानां)
4—Vājasaneyi Brahmins—	,, —	(वाजसनेयिनां)
21—Chittapāvan Brahmins—	,, —	(चित्तपावनानां)
9—Karhāḍā Brahmins—	,, —	(करहाटकानां)
7—Karnāṭaka Brahmins—	,, —	(करनाटकानां)
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The first name in the Karhāṭaka group we find is the name "कृष्णंभटजी अर्डे," while the sixth name is "बाळमुकुंद अड." The letter is dated *Śaka 1723* or *Saṁvat 1858*[4] = *A. D. 1801*. I feel no doubt that "कृष्णंभटजी अर्डे" of this letter of *A. D. 1801* is no other than "Kṛṣṇabhaṭṭa Ārḍe," the writer of several works on logic and other subjects mentioned by me in this paper. If this identification is accepted we have evidence to believe that this author flourished between say *A. D. 1750* and *1825* or so. As the India Office Library Ms. of अनुमानमञ्जूषा is dated *A. D. 1801* we have to suppose that Kṛṣṇabhaṭṭa was a full-fledged logician by *A. D. 1800* and that many of his works on logic may have been completed before this year. Presuming now that he was about 50 years old in *A. D. 1801* when he consented to a letter of decision in a caste-dispute we may reasonably allow for him a life-period between *A.D. 1750* and *1825* (about 75 years).

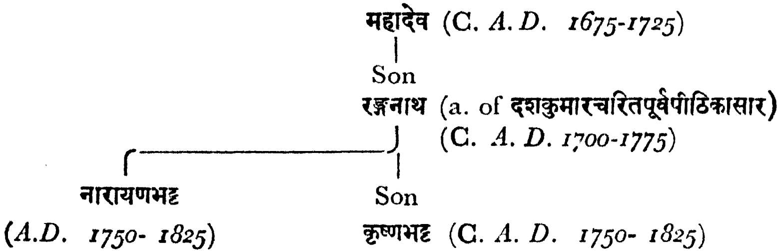
1 In the *Gotrāvali* of Karhāḍā Brahmins with me I find the surname "Ārḍe" with *gotras* (1) काश्यप and (2) भारद्वाज. It is necessary to examine the works of Kṛṣṇabhaṭṭa Ārḍe and find out if he has recorded his own gotra incidentally.

2 "कायस्थ प्रभूंच्या इतिहासाचीं साधनें, Vol. I, No. 11 (Nirnayasagar Press, Bombay— "ग्रामण्याची हकीकत"–प्रकरण दुसरें), pp. 27-34.

3 *Ibid*, pp. 30—32 : The letter begins — "स्वतिश्रीमद्दंडकारण्यांतर्गतभीमरथीनाभिद्रय-संगत्योपलक्षितपुण्याह्वयग्रामस्थ दाक्षिणात्यराजर्षिधर्माधिकारी प्रांत पुणें व आठघरे व समस्त ब्राह्मणान्प्रतिआर्यावर्तैकदेश आनंदवनत्रिकंटकाविराजिताविमुक्त क्षेत्रस्थ भट्टधर्माधिकारिशेषप्रभृती-मनेका नतयो विलसंतु, चैत्रशुक्लपंचम्यवधि अत्रत्यक्षेममस्ति भावत्कं तदनुदिनमेधमानमा-शास्महे. विशेषस्तु भाषया—आपण माघकृष्ण दशमीचीं पत्रें पाठविलीं ती पावलीं, etc."

4 The letter ends—"कळावें. सुज्ञान्प्रत्यलं पल्लवितेनेत्यनेका नतयो विलसंतु. शाके १७२३ दुर्मतिनामसंवत्सरे संवत् १८५८."

The Ms. of दशकुमारचरितपूर्वपीठिकासार mentioned by Stein[1] as the work of "रङ्गनाथ आरड" son of महादेव consists of 19 folios (complete). This रङ्गनाथ seems to be the same as the father of कृष्णभट्ट आर्डे, the logician, who was also called रङ्गनाथ as we have already seen. The genealogy of this logician will now be as follows :—



नारायणभट्ट mentioned by कृष्णभट्ट आर्डे as his brother seems to be different from his namesake, the son of लक्ष्मीधरभट्ट.[2] This नारायण लक्ष्मीधर आरड composed a work on *dharmaśāstra* called the गृह्याग्निसागर of which Aufrecht (CC II, 32) records the following Mss. :—

"गृह्याग्निसागर or प्रयोगसार by नारायणभट्ट. Bhāu Dāji 102, IO,48.1815. Rgb. 292, Stein 87."

"गृह्याग्निसागर alias प्रयोगसार by नारायणभट्ट, son of लक्ष्मीधरभट्ट surnamed आरड (आरडे), quotes रामाण्डारव्याख्या on धूर्तस्वामी's भाष्य on आपस्तम्ब, प्रयोगपारिजात, प्रयोगरत्न, निर्णयसिन्धु, भट्टोजिदीक्षित, परशुरामप्रताप and रामवाजपेयी and his own श्राद्धसागर. Later than 1650 A.D."

Ms. "Rgb. 292" in the above entry of Aufrecht is identical with Ms. *No. 292* of *1884-87* in the Govt. Mss. Library at the B. O. R. Institute, Poona. There is another Ms. of the work in the above library, *viz.*, *No. 63 of 1895-1902* which is dated *Śaka 1693*=*A. D. 1771*. Ms. *No. 292 of 1884-87* is dated *Saka 1649-*=*A. D. 1727*. It is thus clear that नारायण लक्ष्मीधर आरड, the author of the गृह्याग्निसागर, flourished earlier than *A. D. 1727* and later than *A. D. 1612*, the date of निर्णयसिन्धु, which is quoted on folio 122a of Ms. *No. 292 of 1884-87*[3] as follows :—

"निर्णयसिंधौ पाराशरमाधवीये कात्यायनः"

On the strength of the above evidence we can assign this author to the period *A.D. 1650—1725* and consequently he is entirely different

[1] *Cata. of Jammu Mss.* by Peterson (1894), p. 81.
[2] *Vide His. of Dharma.* I by P. V. Kane, p. 540.
[3] This Ms. begins—

श्रीगणेशाय नमः ॥
नत्वा कृष्णपदांभोजं गणेशं शंकरं शिवं ॥
लक्ष्मीधरं च पितरं भट्टनारायणं तथा ॥
यथाज्ञानं विचार्याथ पक्षशिष्टैरनुष्ठितं ॥
त्रीणि सूत्राणि तद्ग्रंथानालोक्यान्यांश्च भूरिशः ॥
आरडेत्युपनामा वै भट्टनारायणः सुधीः ॥
गृह्याग्निसागरं चैव कुरुते शिष्टतुष्टये ॥

from नारायण रङ्गनाथ आरडे, the brother of कृष्णभट्ट आरडे (*A.D. 1750 to 1825*). The Ms. of this work in the India Office Library is a late copy dated Śaka 1741 (=*A.D. 1819*). Professor H. D. Velankar has described two Mss. of this work in his catalogue of the B.B.R.A. Society's Mss.,[1] but these Mss. bear no dates. The work is a compilation treating of rites regarding the maintenance of the sacred fire, and rules of expiation in cases of irregularities. The author notes some Marathi equivalents[2] for Sanskrit words on folio 8 (Ms. *No. 292 of 1884-87*). It is now clear that the author of the गृह्याग्निसागर belongs to a branch of the Ārḍe family which I cannot link up with the branch represented by कृष्णभट्ट आर्डे. The two branches may be represented chronologically as follows :—

लक्ष्मीधर (*A.D. 1600— 1660*)
|
Son
नारायणभट्ट (*A.D. 1650— 1725*)

........महादेव (*A.D. 1675— 1725*)
|
Son
रङ्गनाथ (*A.D. 1700— 1775*)
| × (कमला)[3]
Sons
|
नारायण (*A. D. 1750-1825*) — कृष्णभट्ट आर्डे (*A. D. 1801*) बाळमुकुंद आर्डे

The Ms. ends on folio 124—

"इति श्रीमदारडोपनामक लक्ष्मीधरसूनुनारायणभट्टकृतगृह्याग्निसागरः समाप्तः। शके १६४९ प्लवंगसंवत्सरे वैशाखवदि द्वितीयायां सौम्यवासरे लिखितमिदं पुस्तकं श्रीभीमारमण-विठ्ठलार्पणमस्तु ॥६॥...........

आरडेत्युपनाम्ना वै भट्टनारायणेन च ॥
त्रीणि सूत्राणि तद्ग्रंथानालोक्यान्यांश्च भूरिशः ॥
सर्वलोकोपकाराय कृतो गृह्याग्निसागरः ॥६॥

This is followed by the following endorsement in red ink—

"॥ गोविंदभट पुराणीक माळवणकर याचे पुस्तक अ......हे सत्य ॥"

[1] *Vide* pp. 214-215 of *Velankar's Catalogue* (Vol. II, 1928) Mss. Nos. 679 and 680.

[2] These are : कालायकाः=वाटाणे; तिंतिणि=चिंचा; लवली=मरीची.

[3] *Vide* p. 121 of *Hultzsch Report* II (Madras, 1896) Ms. No. 1240—Comm. on Gadādhara's दोषसामान्यलक्षण by कृष्णभट्ट आर्डे. Begins—

"आरडीयाह्वकृष्णेन रचिता टिप्पणी परा।
गदाधरीयगूढिळानानंदयतु नित्यशः ॥
गदाधरमतार्थेषु दोषसामान्यलक्षणे ।
नम्र पंचदुरितार्थानां कृत्स्नानामेवकारिका ॥
वैकुंठमध्यावसतोः कमलारंगनाथयोः ।
देहजः कृतवानेनां कृष्णो नारायणानुजः ॥"

The Ms. of Kṛṣṇabhaṭṭa's commentary on the *Nirṇanyasindhu* described by Burnell[1] was copied at Benares in *A. D. 1829*.

In one of the Sanskrit addresses[2] presented to Warren Hastings in *A.D. 1796* by Benares Pandits, I find the following signatories :—

"(42) *Krishna Bhattha*"

"(44) *Bala Mookoonda*"

On this address there are signatures of more than 67 Mahārāṣṭra Brahmins, etc., among which the above names occur. I am inclined to think that these persons are identical with कृष्णभट्ट आर्डे and बाळमुकुंद आर्डे of the *1801 A.D.* letter from the Benares Pandits to Poona Pandits already referred to by me in this paper. Though the above signatures are not followed by the surnames of the writers in the *1796* address the circumstantial evidence is strong enough to support my identification of these writers with their namesakes in the *1801* letter. In fact I find that many signatories are common to both the documents as will be seen from the following comparison :—

Letter from Benares—*A.D. 1801*	Sanskrit Addresses to Warren Hastings—*A.D. 1796*, from Benares Pandits
रामचंद्रभट्ट तारे	*Rama-Chandra* Sarmâ surnamed *Tarâ*
हिरापंडित शेष	*Heera namee* surnamed *Sesha*
हरिरामपंडित शेष	*Sesha* Hareo Rama Panta
मुकुंद देव	Mookoonda *Deva*
बचंभट्ट मौनी	Bacham Bhattha Sarma surnamed *Mownee*
जयराम जोशी	*Astrologer* Jaya Rama
चिंतामणभट्ट कार्लेकर	Cheenta Manee surnamed *Kaarlakar*
बाळदीक्षित अयाचित	Bala Krishna Deekshita surnamed *Ayacheeta*
कृष्णंभटजी अर्डे	Krishna Bhattha
बाळमुकुंद अर्डे	Bala Mookoonda
कृष्णदीक्षित लेले	Krishna *Lalla*
चिंतामणदीक्षित कानडे	Cheentamanee Deeksheeta surnamed *Karnataka*

1 *Vide* p. 130 of *Burnell's Catalogue of Tanjore* Mss., 1879.

"निर्णयसिंधुदीपिका by कृष्णशर्मन् (कृष्णभट्ट) younger brother of नारायण. The author was a Mahraṭhā of Benares (See Hall's *Vāsavadattā* pref., p. 47, note). Begins—

लक्ष्मीनारायणं नत्वा पितरौ च गुरूनपि ।
कृष्णशर्मावितनुते सारार्थां सिन्धुदीपिकाम् ॥ etc."

Written at Benares, *Saṁat 1886.*

(*Vide* p. 8579 of *Des. Cata. of Tanjore Mss.*, Vol. XVIII, 1934)—Ms. No. 18206.

2 *Vide Journal of Tanjore S. M. Library*, Vol. II, No. 1, pp. 10—14 (my paper on "Testimonials of Good Conduct to Warren Hastings by the Benares Pandits—A.D. 1796.) See signatories to the second address to Warren Hastings.

It appears clear to me that Kṛṣṇabhaṭṭa Ārḍe, the logician, was a signatory to the Sanskrit address to Warren Hastings, an English translation of which by Mr. Wilkins is found on pp. 755-768 of the *Debates of House of Lords*, London, 1797. Kṛṣṇabhaṭṭa did not, therefore, die about *A.D. 1771*, as suggested by Dr. S. Vidyabhusana in his *History of Indian Logic*.

Our Kṛṣṇabhaṭṭa Ārḍe was a junior contemporary of the celebrated author Bālambhaṭṭa Pāyaguṇḍe, the author of the *Bālambhaṭṭi*, who is assigned by M. M. Professor P. V. Kane[1] to the period *A.D. 1730-1820* and to whom Colebrooke had entrusted the compilation of a work called *Dharmaśāstra Saṅgraha* about *A.D. 1801*. On the Benares letter of *A.D. 1801* to which Kṛṣṇabhaṭṭa Ārḍe is a signatory we find the signature of "बाळंभटजी पायगुंडे" who is no other than his namesake in the employ of Colebrooke in *May 1801*.[2]

It is difficult to fix the chronology of the several works of Kṛṣṇabhaṭṭa Ārḍe. I have already observed that the India Office Library Ms. of the Kāśikā of this author is dated *A.D. 1801*. He must have written his works on *Nyāya* prior to *A.D. 1800* or so. In his commentary on Gadādhara's दोषसामान्यलक्षण our author refers to his parents कमला and रङ्गनाथ as residing in heaven (वैकुंठमध्यावसतोः **कमलारङ्गनाथयोः**). This statement shows that Kṛṣṇabhaṭṭa composed the commentary in question when his parents were no longer living. Possibly his parents died before *A.D. 1800*.

P. S.—I have assigned नारायण लक्ष्मीधर आरडे to the period *A.D. 1650-1725*. This conclusion is corroborated by the following additional evidence:—

(1) A *nirṇayapatra* dated *A.D. 1657* contains the following endorsement —"संमतं **नारायणभट्ट आरडे** इत्युपनाम्नः" (Vide pp. 78-81 of चितळेभट्ट प्रकरण by R. S. Pimputkar, Bombay, 1926).

(2) H. P. Shastri [*Notices*, III, 1907, Calcutta] describes a Ms. of लक्षहोमकारिका by नारायणभट्ट आर्डे, which is dated *Saṁvat 1783=A. D. 1727*. We have already pointed out that the B. O. R. I. Ms. of गृह्याग्निसागर of नारायणभट्ट आर्डे is dated *Śaka 1649=A.D. 1727*.

[1] *Vide* p. 462 of *History of Dharmaśāstra*, I (1930).

[2] P. V. Kane: *History of Dharma*. I, p. 461—Kane mentions the following dated Mss. of Bālambhaṭṭa's works:—

(1) **बालंभट्टी**—Ms. in Benares Palace Library—*A. D. 1774-75*.

(2) **उपाकृतितत्व**—Ms. described by Stein in his *Catalogue of Jammu Mss.* —*A.D. 1791-92*.

I may add the following Ms. to the above list:—

(3) मिताक्षराव्याख्या (व्यवहारप्रकरण) 407 folios—*Saṁvat 1850=A. D. 1794* (*Vide* p. 147 of Poleman's *List of Indic Mss. in U. S. A.*, etc., 1938).

THE CREED OF IBN BABAWAYHI

By

ASAF A. A. FYZEE

Government Law College, Bombay

THE creed of Ibn Bābawayhi (died, 381/991), better known as Shaykh Ṣadūq in Shiite circles,[1] is of importance from several points of view. In comparison with other creeds available to us, it is one of the earliest as belonging to the 4/10th century. Shaykh Mufīd (died, 413/1022) was a few years junior to Ṣadūq and his creed *an-Nukatu'l-I'tiqādīya*,[2] together with his critique of Ṣadūq's creed, *Taṣḥīḥu'l-I'tiqādāt*,[3] furnish valuable materials for the study of the Ithnā 'Asharī creed in its early forms.

The purpose of this paper is to give the main elements of Ibn Bābawayhi's creed in the form of clear-cut propositions, and then to add notes from Mufīd's *Taṣḥīḥ* and *Nukat*. In the last part of the paper an attempt will be made to compare the views of Ṣadūq with those of Mufīd for obtaining a correct perspective and a juster estimate of the main problem.

Ṣadūq's creed is of importance from another point of view as well. He was one of the greatest and most authoritative traditionists of the Ithnā 'Asharīs, being the author of *Man lā Yaḥḍuru-hu'l-Faqīh* or "Every Man His own Lawyer."[4] And his creed is therefore of the highest authority, being perhaps the earliest of the recognized creeds. Nevertheless in a number of questions Mufīd differs from his older contemporary ; and his criticisms and objections seem to be justified by the subsequent development of Shiite theology. And yet—so great is the respect for Shaykh Ṣadūq—the author of *Rawḍātu'l-Jannāt* observes that where the two divines differ, both must be considered to be right.[5] It will be seen, however, that gradually in the course of time, the differences between Ṣadūq and Mufīd led to others, and when we come to *an-Nāfi' Yawmi'l-Ḥashr*, a commentary on *al-Bābu'l-Ḥādī 'Ashar*,[6] the creed becomes highly philosophical and its whole shape has altered.

The *I'tiqādāt* of Ibn Bābawayhi, examined in relation to other creeds, is not merely a creed, but contains a great deal of argumentation based upon citations from the *ḥadīth* and the Qur'ān. It also contains matter

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1 *Risālatu'l-I'tiqādāt,* trans. under the caption *A Shi'ite Creed,* I. R. A. Ser. No. 9, Bombay, 1942, where a full account of the life and works of Sh. Ṣadūq will be found. This work is referred to as *SC*.

2 Baghdād. 1343 A. H. Referred to as *Nukat.*

3 For details regarding this work, see *SC*, xii-xiii, and p. 76. Abbreviated, *Taṣ.*

4 *SC*, 15-16.

5 Page 563, line 25 ; *SC*, 12.

6 *al-Bābu'l-Ḥādī 'Ashar* by Ḥasan b. Yūsuf b. 'Alī Ibnu'l-Muṭahhar al-Ḥillī, with a commentary by Miqdād-i Fāḍil. Trans. by W. M. Miller. London, 1928 (Royal Asiatic Society, Oriental Translation Fund, N. S., Vol. XXIX). Abbreviated *BHA*.

which may strictly be considered as irrelevant in a creed, *e.g.*, principles of *ḥadīth* criticism (Chapters 42 and 45) and rules of the medical science (Ch. 44). But this is not surprising ; for as Wensinck says, "A creed may take various forms : it may consist only of a few words or may be a whole treatise ; it may be a doxology, a short phrase, or a work on dogmatics. This is as true of Islam as it is of Christianity ; moreover, in both religions the short formula is anterior to the creed, which in its turn is anterior to the treatise on dogmatics."[1]

Among the Ithnā 'Asharīs, however, the sequence may well have been (1) the short formula, (2) the creed with traditions and Qur'ānic quotations, like Ṣadūq's *I'tiqādāt*, (3) the shortened creed, almost a catechism, like 'Allāma-i Ḥillī's *al-Bābu'l-Ḥādī 'Ashar*, (4) the regular creed with the beginnings of *kalām*, like *an-Nāfi' Yawmi'l-Ḥashr*, and lastly, (5) the theological statement of the whole religion or full discussion of the fundamental principles of the faith from various points of view. Examples of these are legion, and are to be found much later, about the tenth/sixteenth century onwards. For these reasons it is necessary to analyse the creed and state it in its simple form, in order to see how far Mufīd differs from Ṣadūq.

I

The creed of Ibn Babawayhi, shorn of arguments and citations from the Qur'ān and the *ḥadīth*, may be stated as follows :

Art. 1. Allah is One (*wāḥid*) and absolutely Unique (*aḥad*). (*SC*, 25)

Art. 2. Allah is Prior (*qadīm*); always existing ; the Hearing and Seeing One (*samī'*, *baṣīr*); the Omniscient (*'alīm*); the Wise (*ḥakīm*); the Living (*ḥayy*) ; the Everlasting (*qayyūm*) ; the Mighty (*'azīz*) ; the Holy (*quddūs*) ; the Knowing One (*'ālim*) ; the Powerful (*qādir*) ; the Self-Sufficient (*ghanī*). (*SC*, 25)

Art. 3. Allah cannot be described in terms of accident, essence, body, form, length, breadth, weight, lightness, quiescence, motion, place, or time. (*SC*, 26)

Art. 4. Allah is beyond the limitations of transcendence (*tanzīh*) and immanence (*tashbīh*). (*SC*, 26)

Art. 5. Allah uses expressions in the Qur'ān in a metaphorical sense ; to wit, "scheming" (*makr*); "beguiling" (*mukhāda'a*); "mockery" (*istihzā'*); and "forgetfulness" (*nisyān*). (*SC*, 29)

Art. 6. Allah possesses two kinds of attributes,—of the Essence (*dhāt*) and of Actions (*af'āl*).

The attributes of the essence are mentioned in Arts. 1 and 2 ; the other attributes are attributes of His actions, *e.g.*, Creator (*khāliq*, *khallāq*); the One possessed of Action (*fā'il*), Will (*shāyi'*) and Intention (*murīd*); the Approver (*rāḍī*) ; the Disapprover (*sākhiṭ*) ; the Provider (*rāziq*) ; the Bountiful One (*wahhāb*) ; the Speaker (*mutakallim*).

The attributes of His action are created. (*SC*, 30-31)

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[1] *The Muslim Creed*, 1. Abbreviated, *MC*.

Art. 7. Human responsibility (*taklīf*) is proportionate to human capacity. (*SC*, 31)

Art. 8. Human actions are created (*makhlūqa*). Allah possesses foreknowledge (*khalq taqdīr*), but does not compel men to act in a particular way (*khalq takwīn*). (*SC*, 32)

Art. 9. There is neither complete constraint (*jabr*), nor complete freedom (*tafwīḍ*) regarding human actions. (*SC*, 32)

Art. 10. Allah possesses Will (*mashī'a*) and Intention (*irāda*); He approves (*riḍā'*) and disapproves (*lam yuḥibba*). (*SC*, 33)

Art. 11. Destiny (*qaḍā'*) and Decree (*qadar*) are great secrets; man cannot attain complete knowledge regarding them. Hence discussion concerning them is forbidden. (*SC*, 36-37)

Art. 12. Allah has created man with a natural disposition (*fiṭra*) towards the true faith. (*SC*, 38-39)

Art. 13. Human capacity (*istiṭā'a*) depends upon four conditions:

(a) freedom in respect of action;

(b) good health;

(c) possession of limbs;

(d) capacity to act. (*SC*, 40)

Art. 14. Allah creates out of nothing and destroys what He wills. (*SC*, 41-42)

Art. 15. (Vain) disputation (*jadal*) and (futile) contention (*mirā'*) about Allah are forbidden. (*SC*, 43-44)

Art. 16. The Tablet (*lawḥ*) and the Pen (*qalam*) are angels. (*SC*, 44)

Art. 17. The Chair (*kursī*) is the receptacle of all created things, including the Throne (*'arsh*). Alternatively, it is Allah's knowledge. (*SC*, 45)

Art. 18. The Throne (*'arsh*) is carried by the whole of creation. Alternatively, it is knowledge. (*SC*, 46)

Art. 19. Souls (*nufūs*) and spirits (*arwāḥ*) were the first of created things. They are immortal. (*SC*, 48-49)

Art. 20. The prophets (*anbiyā'*), the apostles (*rusul*) and the Imāms possess five spirits: *rūḥu'l-qudus,—īmān,—quwwa,—shahwa,—mudraj.*

True believers possess four spirits: *rūhu'l-īmān,—quwwa,—shahwa,—mudraj.*

Unbelievers and beasts possess three spirits: *rūḥu'l-quwwa,—shahwa,—mudraj.* (*SC*, 52-53)

Art. 21. Death brings either (i) bliss, (ii) misery or (iii) uncertainty, in the case of the believer, unbeliever or doubter, respectively. (*SC*,53-54)

Art. 22. Mankind will be questioned in the grave. (*SC*, 60)

Art. 23. The belief in resurrection (*raj'a*) is a necessary article of faith. (*SC*, 62 ; cp. art. 25)

Art. 24. Transmigration of souls (*tanāsukh*) does not take place, (*SC*, 65)

Art. 25. The Return after death (*ba'th*) is a necessary article of faith. (*SC*, 66 ; cp. art. 23)

Art. 26. It is necessary to believe in the Pond (*ḥawḍ*). (*SC*, 66)

Art. 27. Intercession (*shafā'a*) will be enjoyed by the true believer, regardless of the commission of sins, great or small. Those who repent are not in need of intercession. The power to intercede belongs to prophets (*anbiyā'*), Imāms and certain believers. (*SC*, 67)

Art. 28. Sceptics, polytheists and unbelievers will not be forgiven ; but the sinful among the believers may be. (*SC*, 68)

Art. 29. Allah's Promises (*wa'd*) and Threats (*wa'īd*) will be fulfilled. (*SC*, 68)

Art. 30. Human actions are duly recorded by angels. (*SC*, 69)

Art. 31. Allah is just. He requites a good act with a good act, and an evil act with an evil act. (*SC*, 70)

Art. 32. Salvation depends upon Grace (*tafaḍḍul*), not merely on good acts. (*SC*, 51, 71, 76)

Art. 33. Purgatory (*a'rāf*) is a wall between Paradise and Hell. (*SC*,71)

Art. 34. *Ṣirāṭ* is the Bridge to Hell. Alternatively, it is a name for the Imāms. (*SC*, 34)

Art. 35. Mankind have to traverse many mountain-passes (*'aqabāt*) upon the Ṣirāṭ ; these are the obligatory acts (*e.g.*, *walāya*, *mirṣād*, *amr*, *nahy*, *raḥm*, *ṣalāt*, *amāna*, etc.). They will be stopped and questioned at each one of these passes. (*SC*, 72-73, 74)

Art. 36. The Reckoning (*al-Ḥisāb*) and the Scales (*al-Mawāzīn*) are real. Allah will take the reckoning of the Prophets and Imāms ; prophets will take the reckoning of the *awṣiyā'*; and *awṣiyā'* will take the reckoning of the communities. (*SC*, 34)

Art. 37. Paradise (*al-Janna*) is a permanent abode (*dāru'l-baqā'*), and an abode of safety and bliss. (*SC*, 77-78)

Art. 38. Hell (*Jahannam*) is a place of degradation. Polytheists will remain there permanently ; but monotheists, even though sinful, will be taken out of it after punishment. (*SC*, 79-80)

Art. 39. Paradise and Hell are created. (*SC*, 81)

N. B. **The Garden of Adam is to be distinguished from Paradise.**

Art. 40. Descent of revelation takes place in the following manner : When Allah wishes to speak, a tablet comes into contact with the forehead of Isrāfīl and he reads it. Isrāfīl conveys it to Mīkā'īl ; Mīkā'īl, to Gabriel ; and Gabriel, to the prophets. (*SC*, 82-83)

Art. 41. The Qur'ān was revealed in one lot, during Ramaḍān, on the Night of Power at al-Baytu'l-Ma'mūr. Later it was revealed to the Prophet during the space of twenty years. (*SC*, 83)

Art. 42. The Qur'ān is the Word or Speech (*kalām*) of Allah. (*SC*, 84)

Art. 43. The Qur'ān is created. (*SC*, 85)

Art. 44. The extent (*mablagh*) of the Qur'ān is that between the two boards (*daffatayn*); it is not greater. (*SC*, 85)

Nothing has been added to or subtracted from it. (*SC*, 87)

Art. 45. The Qur'ān is not exhaustive of all revelation ; much of revelation in the shape of traditions is outside of the text of the Qur'ān. (*SC*, 86-87)

Art. 46. Prophets (*anbiyā'*), apostles (*rusul*) and Imāms (*ḥujaj*) are more excellent than angels. (*SC*, 89-90, 92)

Art. 47. Angels are spiritual beings and are sinless (*ma'ṣūm*). (*SC*,91)

Art. 48. The total number of prophets is 124,000, and each prophet has a *waṣī*. Obedience is implicitly due to prophets and *awṣiyā'*, for their commands are the commands of Allah. (*SC*, 92-93)

Art. 49. The Masters of the Religious Paths are Noah, Abraham, Moses, Jesus and Muḥammad. And Muḥammad is their leader and the most excellent of them. (*SC*. 93)

Art. 50. After the Prophet Muḥammad the most excellent of mankind are the Twlelve Imāms : (i) 'Alī, (ii) Ḥasan, (iii) Ḥusayn, (iv) 'Alī Zaynu'l-'Ābidīn, (v) Muḥammad al-Bāqir, (vi) Ja'far aṣ-Ṣādiq, (vii) Mūsā al-Kāẓim, (viii) 'Alī ar-Riḍā', (ix) Muḥammad at-Taqī, (x) 'Alī an-Naqī, (xi) Ḥasan al-'Askarī, (xii) Muḥammad al-Muntaẓar al-Qā'im bi-amri'l-lāh. (*SC*, 95-96)

Art. 51. The Qā'im (Twelfth Imām) is living, but invisible (*ghā'ib*) to the eyes. (*SC*, *ibid.*)

Art. 52. Implicit obedience is due to the Imāms, for their commands are the commands of Allah. (*SC*, 96)

Art. 53. Devotion (*walāya*) to the Imāms is a necessary article of faith. (*SC*, 96-97)

Art. 54. The world cannot exist without the Proof of Allah (*ḥujja*), *i.e.*, the Imām. (*SC*, 97)

Art. 55. The Twelfth Imām will, on his manifestation, "fill the earth with justice and equity, just as now it is full of oppression and wrong." (*SC*, 98)

Art. 56. Prophets (*anbiyā'*), apostles (*rusul*), Imāms and angels are infallible and sinless (*ma'ṣūm*). (*SC*, 99-100)

Art. 57. Excess in belief (*ghuluww*) and belief in Delegation (*tafwīḍ*) are not permissible. (*SC*, 99-100)

Imāms have no power of creating or providing for mankind. (*SC*, 104)

Art. 58. The Prophet and Imāms were all martyrs and they died natural deaths. (*SC*, 101-102)

Art. 59. The evil-doers (*ẓālimūn*) are accursed and dissociation (*barā'a*) from them is necessary. A wrongful claimant to the Imāmat, as well as he who wrongfully ascribes Imāmat to those who are not entitled to it, are evil-doers. (*SC*, 105, 107-108)

Evil-doers and enemies of the Prophet and Imāms are unbelievers. (*SC*, 109)

Art. 60. (a) He who denies the apostleship of the Prophet has denied God His divinity.

(b) He who denies the Imāmat of 'Alī after the Prophet denies the apostleship of the Prophet.

(c) And he who denies any Imām after 'Alī denies the apostleship of the Prophet Muḥammad. (*SC*, 107-108)

Art. 61. He who fought 'Alī was an unbeliever. (*SC*, 108)

Art. 62. Fāṭima, the Prophet's daughter, is the leader of women in the world. (*SC*, 108-109)

Art. 63. Absolution is necessary in respect of the four idols : Yaghūth, Ya'ūq, Naṣr and Hubal, and of the four female idols: al-Lāt, 'Uzzā, Manāt and Shi'rā ; and also in respect of those who worship them. (*SC*, 109)

Art. 64. *Taqīya* (dissimulation) is necessary until the Qā'im appears. (*SC*, 110-111)

Art. 65. The ancestors of the Prophet, from Adam down to 'Abdu'l-lāh, were all believers.

Abū Ṭālib and Āmina bint Wahb (Prophet's mother) were believers.

'Abdu'l-Muṭṭalib (Prophet's grandfather) was a *ḥujja* and Abū Ṭālib was his *waṣī*. (*SC*, 112-113)

Art. 66. The Alids are descendants of the Prophet. Devotion (*walāya*) to them is obligatory. (*SC*, 96, 113)

Art. 67. The Alids who act sinfully will be punished doubly, and those who act righteously will be rewarded doubly. (*SC*, 114)

Art. 68. Detailed reports take precedence of the summary ones. (*SC*, 116)

Art. 69. Unless there is a specific prohibition, all things are permitted. (*SC*, 116)

Art. 70. Reports about medical matters are of various kinds. (The five categories. *SC*, 117)

Art. 71. Authentic reports, although differing in outward form, accord in their true meanings with the Book of Allah. (*SC*, 118)

Art. 72. There are four kinds of reporters—

(I) Hypocrites simulating Islām.

(II) Persons having no precise recollection.

(III) Persons remembering a command, but having no knowledge of its abrogation.

(IV) Persons with precise recollections, knowing *nāsikh* and *mansūkh* (*SC*, 120-121)

[The Prophet trained 'Alī. *SC*, 122-124]

Art. 73. The inconsistencies in the Qur'ān are only apparent. (*SC*, 125-128)

II

The creed of Ibn Bābawayhi as stated above represents the state of Shiite belief during the IV/X century. There is apparently no commentary written upon it, but his younger contemporary, Shaykh Mufīd, wrote a critique which is most valuable for historical and dogmatic reasons. While I was preparing the translation of the *I'tiqādāt* of Shaykh Ṣadūq, I was unfortunately unable to have access to this comparatively little known work, *Taṣḥīḥu'l-I'tiqādāt*. R. Strothmann mentions that it was printed in *al-Murshid*, a learned Arabic periodical of Baghdād.[8] On further inquiry I found that some volumes of *al-Murshid* were preserved in the State Library, Rāmpūr. Unfortunately, however, only three volumes were to be found, and these contained the text of the *Taṣḥīḥ* in an incomplete form.[9] In my further search for Mss., I learnt that a copy existed at the Āṣafiyah Library, Hyderabad, Deccan, and another with a private owner at Lucknow. Luckily for me Dr. Rāḥatu'l-lāh Khān, Superintendent, Āṣafīyah Library, arranged for a transcription of the Hyderabad Ms. and through his kindness I obtained my copy in February, 1942.

Before giving details of the *Taṣḥīḥ*, a few words may be said about its author, the celebrated Shaykh Mufīd. His full name was Abū Abdi'l-lāh Muḥammad b. Muḥammad b. an-Nu'mān al-Ḥārithī al-Baghdādī. Born at Baghdād 333 or 338/945 or 950, he soon acquired fame as a learned theologian. His correspondence was voluminous and he carried on learned controversies with other contemporary divines. He was the teacher of Najāshī, who in his *Rijāl* ascribes a large number of works to him. Among these is the *Taṣḥīḥu'l-I'tiqādāt*, in which he discusses the chief points of difference between himself and Shaykh Ṣadūq. It appears that the Naqīb al-Baghdādī Sharīf al-Murtaḍā wrote a commentary on the *Taṣḥīḥ*. Mufīd died on Ramaḍān 28, 413/ November 26, 1022, and is buried beside Ṣadūq at the feet of the Ninth Imām Muḥammad al-Jawād at Kāẓimayn.[10]

The *Taṣḥīḥ* is a small treatise. My copy consists of 81 pages, 6 by 9 inches, 15 lines to the page, with wide margins. It is divided into 32 *faṣls*. Each *faṣl* deals with only those points wherein Mufīd differs from Ibn Bābawayhi ; sometimes he merely rests content with developing the point further and giving additional arguments or illustrations. It is not a systematic commentary and not all the matters dealt with are of equal importance.

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8 *Enc. of Islām*, iii. 625-626.

9 *SC*, xiii, 5.

10 For further details, see Najāshī, *Rijāl* (Bombay ed.), 283-287; Khwānsārī, *Rawḍātu'l-Jannāt*, 563 ; R. Strothmann in *Enc. of Islām*, iii. 625-626.

The Hyderabad Ms. is a modern copy transcribed in Shawwāl, 1265/August-September, 1849. The scribe is Muḥammad Ṣādiq Fayḍābādī. The press-mark is Kalām ى, No. 102. It was copied for me by Muḥammad Qudrati Raḥīm during Dhū'l-Ḥijja, 1360/December, 1941-January, 1942.

The contents of the *Taṣḥīḥ* are so valuable as to merit serious study; for this reason, it is most unfortunate that the Hyderabad Ms. is both modern and extremely inaccurate. Unless compared with other older and better Mss. and edited critically, it cannot be regarded as satisfactory for the purposes of research. The text printed in *al-Murshid*, despite the undoubted value of the editor's notes, is also unsatisfactory, containing as it does many *lacunae* and insurmountable difficulties. Thus a critical edition of the text of the *Taṣḥīḥ* is much to be desired.

For the views of Sh. Mufīd, in addition to the *Taṣḥīḥ*, we have another small but significant work. This is *an-Nukatu'l-I'tiqādīya* by Sh. Mufīd, edited with valuable notes by Hibatu'd-dīn Muḥammad b. Abī'l-Qāsim ash-Shahristānī, Baghdād, 1343/1924. It is a small booklet of 64 pages, 4 by 6½ inches, 13-15 lines to a page. I am indebted to Mr. W. Ivanow for drawing my attention to this valuable little treatise, which he very kindly brought for me from Baghdād in the year 1938.

The *Nukat* is a highly philosophical creed in the form of question and answer, and from it it is clear that we have moved a great distance from the *I'tiqādāt* of Ṣadūq. Ṣadūq's creed is full of arguments, *ḥadīth*, Qur'ān, explanation; here we have clear-cut dogmatic answers to equally clear-cut questions.

We shall now consider the views of Shaykh Mufīd, arranging them for the sake of convenience under the different articles of Ṣadūq's creed. The articles on which he has nothing to say are omitted, and I think we may safely assume that he was in agreement with the position taken up by Shaykh Ṣadūq.

AD ART. 4. MEANINGS OF WORDS

(1) Ṣadūq explains that there are many metaphorical expressions in the Qur'ān which lead ignorant persons to believe in *tashbīh* (immanence). And he says that in Qur. 39, 57 *sāq*, lit. "leg," means "the result or the consummation of the affair and its intensity" (*SC*, 27).

Sh. Mufīd comments that يوم يكشف عن ساق refers to the Day of Resurrection when great difficulties will appear, the most important of which are the Reckoning, the punishment of sins, the divulging of secrets, etc., and so *sāq* really refers to *shidda* (*Taṣ.* 2-3).

The Urdu translator Badāyūnī says that the Arabs used to wear long shirts. When they took to flight they used to hold their shirts up and thus came the expression "legs were bared" (Delhi edition, 12).

(2) Similarly Ṣadūq explains *yad*, pl. *ayd*, with reference to Qur. 51,47; 38, 16 and 38, 75 as meaning "strength" (*SC*, 28). Mufīd citing other verses says that it means *ni'ma*, "favour" (*Taṣ.* 3-4), and *yadayn* means *ni'ma* and *quwwa*, "favour and strength" (*Taṣ.* 5).

(3)* Ṣadūq explains that when in the Qur'ān expressions are used indicating that Allah "derides" (Qur. 9, 80), or "schemes" (Qur. 3,87),

or "beguiles" (Qur. 4,141), or "mocks" (Qur. 2, 14), or "forgets" (Qur. 9, 68), the real meaning is that God will *requite them* for their derision, scheming, beguiling, mockery or forgetfulness (*SC*, 29).

Mufīd explains this requital further and adduces the reason that the Arabs often called a thing by its metaphorical name (*Taṣ.* 6).

Ad Art. 6. Attributes of God

The question of the attributes of God is of the utmost importance and in examining the stand taken by Ṣadūq (*SC*, 30-31), we shall see that Mufīd makes it even more clear (*Taṣ.* 7-8). In the *Nukat* the treatment is still more scientific and methodical (*Nukat*, 18-36).

The Shiite doctrine is that the attributes of God may be divided into two classes. In the first class there is no reference to action—*ṣifātu'dh-dhāt ;* in the second, they refer to actions—*ṣifātu'l-af'āl.* The distinction is this that in the case of the attributes of the essence, the opposite cannot be predicated of Allah. You cannot say, for example, that He dies (opposite of *ḥayy*, ever-living), or is weak (opp. of *qādir*), or is ignorant ; and you cannot describe Him as being anything other than living (*ḥayy*), knowing (*'ālim*) and powerful. On the other hand, you can say that Allah is not a creator today ; or that He is not a giver of sustenance to Zayd ; or that He is not the revivifier of an actually dead man, and so forth. And Allah can be described by such contraries as Allah gives and withholds, causes to live and causes to die, etc. (*SC*, 30n). This is a clear distinction between the two classes of attributes.

Ad Arts. 7, 8 and 9. Human Actions

Ṣadūq lays down that God has foreknowledge of things (*'āliman bi-maqādīri-hā*); it is only in this sense that the actions of men are "created" (*SC*, 31-32 ; Najaf ed., 98, top). Therefore *'ilm* can be used to explain *khalq*, *e.g.*, *khalq takwīn* and *khalq taqdīr.*

But Mufīd objects to this explanation. The correct doctrine according to him is that the actions of men are *not created* by God. What is related by Ṣadūq is not an accepted *ḥadīth*, for in the language of the Arabs *'ilm* is never the same as *khalq.* For instance, it cannot be said that he who knew the Prophet "created" him. خالق and عالم are therefore not synonymous (*Taṣ.* 9).

Imām 'Alī an-Naqī was asked about the dogma that the actions of men were created by God ; and he said, "How then can we dissociate from them (actions considered inimical to the Shī'a)?" *Barā'a* would be an impossibility in respect of certain actions which were objected to by the Shī'a (*Taṣ.* 9).

Abū Ḥanīfa asked Imām Mūsā al-Kāẓim concerning human actions. He replied that there were three alternatives : (a) that all actions are from God, or (b) that they proceed jointly from man and God, or (c) that they are from man.

It is unfortunate that in this portion the text of the *Taṣḥīḥ* is corrupt and I have not been able to follow the exact reasoning of Mufīd. But the conclusion at which he arrives is that the first two alternatives are

unsound, and the last, namely that actions proceed from men is the correct view (*Taṣ.* 10). Mufīd adds a number of Qur'ānic verses and other arguments in support of his view (*Nukat,* 24-26).

AD ART. 9. FREE WILL AND PREDETERMINATION

Ṣadūq lays down that there is neither complete constraint (*jabr*), nor complete delegation (*tafwīḍ*), but the matter is midway between the two extremes (*SC,* 32). It is well to remember that complete predestination was affirmed by the Ash'arites and complete freedom, by the Mu'tazilites (*SC,* 32, note 1). Hence the Ithnā 'Asharites thought it best to take a middle course.

Mufīd explains *jabr* as : الحمل على الفعل و الاضطرار اليه بالقهر و الغلبة that is, "compulsion in respect of an act and constraint by reason of coercion or overpowering." This involves ايجاد الفعل فى الحى من غير أن يكون له قدرة على دفعه "the creation of an act in a living being, without his having the power to avoid it" (*Taṣ.* 11). Now those who believe in *jabr* are constrained to go to the length of saying that obedience and disobedience both proceed directly from God ; while those who postulate complete freedom go to the other extreme. This also is not correct.

The "middle course" الامر بين الامرين is the correct doctrine. God has *created* in man the *capacity* to do both good and bad acts. He has commanded man to do good acts and to abstain from bad acts. But God knows (أقدر or قدر) what man is actually going to do ; not that He *forces* him to do those acts (*Taṣ.* 12).

AD ART. 10. INTENTION AND WILL

Ṣadūq explains four expressions : (1) *shā'a,* he wills, (2) *arāda,* he intends, (3) *lam yuḥibba,* he does not like, and (4) *lam yarḍa,* he does not approve (*SC,* 33). He refers to a large number of Qur'ānic verses and ends by a discussion of the case of Imām Ḥusayn. His murder was the cause of God's displeasure and disapproval ; it was not the result of His Intention or Will (*SC,* 35).

Mufīd however says that what is affirmed by Ṣadūq is not clear and leads to error and confusion. Clear intention or will is to be distinguished from mere approval or disapproval. Mufīd cites several verses of the Qur'ān and gives cogent explanations (*Taṣ.* 13-17).

It would appear that Ṣadūq's doctrine is not materially altered and, mostly, it appears to be a quarrel over the choice of words.

AD ART. 11. DESTINY AND DECREE

According to Ṣadūq, "Discussion about *qadar* is forbidden." But the authorities for this proposition are not mentioned (*SC,* 36). According to Mufīd, this is a rare and little known tradition.

Qaḍā' has four meanings : (*i*) *khalq* (creation), (*ii*) *amr* (command), (*iii*) *i'lām* (giving knowledge) and (*iv*) *qaḍā'* (decision) ; and in support of each meaning Mufīd cites verses of the Qur'ān (*Taṣ.* 18). It is also said that it has a fifth meaning, "the completion of an affair."

Ṣadūq's categorical denial of the right of discussion is not approved by Mufīd, who says that although in some respects discussion is prohibited, there is still a certain choice, and there are two aspects of the question. First, discussion is prohibited in the case of those whose words produce evil results and spoil religion ; it does not necessarily apply to all people. For some of the questions were discussed and explained to the people by the Imāms themselves (*Taṣ.* 20). Secondly, discussion is prohibited regarding the cause of creation and command, and not generally (*Taṣ.* 21).

Thus Ṣadūq would have no discussion whatever regarding these questions ; while Mufīd leaves the door open to a certain extent.

AD ART. 15. VAIN DISPUTATION

Mufīd says that discussion may be of two kinds : true (a sincere quest after the truth) or false (discussion without the object of arriving at the truth). The first is not prohibited ; the second is (*Taṣ.* 23-29). After discussion he quotes the *ḥadīth* of Imām Mūsā al-Kāẓim telling Muḥammad b. Ḥakīm that he should speak to the people and expound the truth (*Taṣ.* 26). According to Mufīd, "And as for the prohibition regarding discussion about God, verily this is limited to discussion regarding His immanence (*tashbīh*),—this being a limitation (*taḥwīr*) in regard to wisdom" (text corrupt ?) (*Taṣ.* 27).

But as to discussion about God's Unity, and the denial of His immanence, and the assertion of His transcendence (*tanzīh*) and His sanctification (*taqdīs*)—there are many traditions permitting such discussion (*Taṣ.* 28-29).

Mufīd's explanation appears to be a methodical commentary on Ṣadūq's text, engrafting many exceptions on it.

AD ART. 16. THE TABLET AND THE PEN

On this question there is a sharp difference of opinion between the two doctors. Ṣadūq's doctrine, that the Tablet and the Pen are two angels (*SC*, 44), is objected to by Mufīd (*Taṣ.* 29-30).

The traditions, according to him, make it abundantly clear that the *lawḥ* is a book in which God has, in His power, written down all events that are to happen till the Day of Resurrection. In the Qur'ān we have : *And verily We have written in the Psalms* (zabūr), *after the Reminder* (dhikr) : *My righteous slaves shall inherit the earth,* Qur. 21, 105 (compare Psalms, xxxvii, 29). In this verse *dhikr* means *lawḥ*. And *qalam* is the name of that thing by the instrumentality of which the happenings of the world are recorded. When God intended to acquaint the angels with some secret of His, or send revelation to one of the prophets, the angels were commanded to read the *lawḥ*. Shaykh Ṣadūq himself, while describing the manner in which revelation was sent down, writes that there was a *lawḥ* in front of the two eyes of Isrāfīl. When God desired to send a revelation, the *lawḥ* would be brought in contact with his forehead. Thus it is apparent that the *lawḥ* is not an angel, nor do we find in any dictionary that *lawḥ* and *qalam* are two angels.

AD ARTS. 17 AND 18. THE THRONE

Mufīd says that *'arsh* means *mulk*, "kingdom." Imām Ja'far gives the exact position of *'arsh* in relation to other entities, "If a stone were to be

thrown down from the *'arsh*, it would fall in the middle of al-Baytu'l-Ma'mūr (*SC*, 83) ; and if it were to be thrown from al-Baytu'l-Ma'mūr, it would fall on the Ka'ba (*Taṣ*. 32). The *'arsh* was not created for itself, but for increasing the greatness and the glory of the Creator (*Taṣ*.32). The meaning of *'ilm* given to *'arsh* is purely metaphorical (*ibid.*).

The traditions related about the angels, as being bearers of the *'arsh*, are all rare and based upon the authority of a single narrator.

AD ARTS. 19 AND 20. SOULS AND SPIRITS

Mufīd says that Ṣadūq's discussion about souls and spirits is on the model of the traditionists (على مذهب الحديث) and not in accordance with the real doctrine (دون التحقيق) (*Taṣ*. 33).

Nafs (Soul) literally means four things : (*i*) the essence (*dhāt*) of a thing (*shay'*) ; (*ii*) blood (*dam*) ; (*iii*) breath (*nafas*) ; (*iv*) inclination (*mayl*), or passion (*hawā'*) (*Taṣ*. 33-34).

Rūḥ (Spirit) has also several meanings : (1) life (*ḥayāt*) ; (2) the Qur'ān ; (3) angel (*malak*) ; (4) the Angel Gabriel.

Mufīd differs from Ṣadūq in the belief that spirits were created 2000 years before the creation of bodies (*SC*, 51, line 2). This is a tradition unsupported except by one narrator (*aḥād*).

He considers Ṣadūq's opinion regarding the indestructibility of the soul as savouring of the belief in transmigration, and cites Qur. 55, 26-27, in refutation (*SC*, 49, note 3) and strongly condemns it (*Taṣ*. 36). This is the vital difference between the two theologians.

Spirits are of two kinds : those who proceed to reward as their requital and those who do not. The latter were checked neither by the threat of punishment, nor by the hope of reward (*Taṣ*. 37).

Mufīd quotes a tradition from Imām Ja'far that a believer's or an unbeliever's spirit, each goes to its like on resurrection so that the believer's spirit enters a body like its own and goes into Paradise. Similarly the unbeliever's soul enters a body and goes to Hell (*Taṣ*. 37).

AD ARTS. 21–25. DEATH

Mufīd has a long explanation about various matters, not necessarily differing from Ṣadūq, but giving fuller explanations and adducing other philological proofs. Why pain comes to a Muslim at death, and joy to the unbeliever, is really a question which cannot be fully understood by human intelligence (*Taṣ*. 42-44).

AD ART. 22. QUESTIONING IN THE GRAVE

Mufīd explains that after death two angels come to the man in the grave and question him regarding his faith, Lord, Prophet and Imām. If his answers are satisfactory, they report to the angels of Joy ; if not, to the angels of Torment (*Taṣ*. 45). The angels who go to the unbelievers are named Munkar and Nakīr ; and those who go to the believers are called Mubashshir and Bashīr.

The angels demand only from him who is alive ; they question only him who is capable of understanding (*Taṣ*. 46). This clearly proves

that God gives life after death, and thereafter there may be eternal life, of joy or of torment, as the case may be.

AD ARTS. 29, 31 AND 32. GOD'S JUSTICE AND PURGATORY

On these questions, Mufīd gives fuller explanations and more examples, without necessarily disagreeing with Ṣadūq (*Taṣ*. 49-52).

AD ART. 34. THE BRIDGE

Mufīd begins by saying that *ṣirāṭ* really means a "road" (*ṭarīq*), but here it means a "bridge." The Prophet will stand on the right side and 'Alī, on the left side (*Taṣ*. 52).

AD ART. 35. THE MOUNTAIN-PASSES (SEE *Taṣ*. 54).

AD ART. 36. THE RECKONING AND THE SCALES

Mufīd does not agree with the Ḥashwites and the Mu'tazilites, and says that the Reckoning and the Scales should be taken purely in a metaphorical sense (*Taṣ*. 57).

AD ARTS. 37-39. PARADISE AND HELL

Mufīd says that the inhabitants of Paradise are of various kinds: (1) those who are sincerely devoted to God and enter Paradise, being protected from the torments of Hell; (2) those who have both good and bad acts to their credit—they enter Paradise after being purged of their sins by punishment in Hell or by being forgiven; and (3) those who, like small children, died without doing any bad acts (*Taṣ*. 57-58).

Ṣadūq, in describing the inmates of Paradise, speaks of some who, like angels, will "receive their favours by sanctifying and glorifying God and declaring His greatness" (*SC*, 78-79). Mufīd objects to this very strongly. He cites various Qur'ānic passages which speak of the *ḥūr*, food, drink and pure spouses; thus it is impossible to conceive of Paradise without these delights. He also says that Ṣadūq's doctrine is derived from Christian sources (*Taṣ*. 59).

AD ART. 40. REVELATION

Mufīd says that the tradition adopted by Ṣadūq, about the Tablet coming into contact with Isrāfīl's forehead, is a rare one and is not generally accepted. In reality "*waḥy* is a secret speech": أصل الوحي هوالكلام الخفي (*Taṣ*. 62). The correct doctrine is that sometimes God sent Revelation to the Prophet without any intermediary, and sometimes through the language of angels (*Taṣ*. 61-64).

AD ART. 41. THE REVELATION OF THE QUR'ĀN

The doctrine of Ṣadūq depends upon a single tradition and is not worthy of acceptance. The correct article of faith is that the Qur'ān was revealed piecemeal as necessity arose (*Taṣ*. 64-66; *Nukat*, 27).

AD ART. 56. INFALLIBILITY (SEE *Taṣ*. 676-9; *Nukat*, 44).

AD ART. 57. EXCESS AND DELEGATION

Mufīd defines *ghuluww* as تجاوز الحد والخروج عن القصد "going beyond the limit and deviating from the main purpose." He also explains why such persons are outside the pale of Islam (*Taṣ*. 70).

AD ART. 58. MARTYRDOM OF PROPHETS AND IMAMS

Mufīd says that in the account of the martyrdom of prophets and Imāms (*SC*, 101, 102), there is a mixture of correct and incorrect reports. 'Alī, Ḥasan, and Ḥusayn were murdered and Mūsā al-Kāẓim was poisoned. But it is uncertain how 'Alī ar-Riḍā' was done to death.

The doctrine of *ḥulūl* comes from the followers of Ḥallāj, and is to be rejected entirely (*Taṣ.* 71; *Nukat*, 32-33 and notes).

In the *Shi'ite Creed*, p. 104, last line, I adopted the reading in the Najaf edition مشائخهم as correct; but apparently the correct reading is that of the Delhi edition مشائخ قم. For Mufīd says that Ṣadūq restricts his remarks to the divines of Qum; but in fact, the criticism applies to all men, whether learned or not, and whether they are from Qum or elsewhere (*Taṣ.* 72).

AD ART. 65. TAQĪYA

According to Mufīd, *taqīya* is permissible only in case of necessity and when there is fear of harm, not otherwise (*Taṣ.* 73-75).

AD ART. 70. MEDICINE

Mufīd says that the science of medicine is an authentic one. It is derived by the learned from the prophets. He then discusses a number of reports (*Taṣ.* 75-76).

AD ARTS. 71 AND 72. DIVERGENT TRADITIONS

According to Mufīd, the method of acquiring knowledge from tradition is treated with extreme brevity by Ṣadūq (*Taṣ.* 76). Difference in wording is due to the facts, for sometimes they are general and sometimes special. It is also due to *taqīya* (*Taṣ.* 76-81).

III

We must now try to understand the chief differences between the Shaykhs, Ṣadūq and Mufīd, and see how far later creeds have either adopted or modified their views. We shall therefore consider predestination, immortality of the soul, disputation, the Tablet and the Pen, the prayer of angels and the descent of revelation.

PREDESTINATION (Arts. 8, 9).—According to Ṣadūq, human actions are "created" (*makhlūqa*) *only* in the sense that God possesses foreknowledge of them (*SC*, 31-32). Therefore according to him, "knowledge" under certain circumstances is a kind of creation. Now Mufīd does not agree to this because, first, "knowledge" is not "creation"; and secondly, man is entirely responsible for his actions.

But in reality their views are not irreconcilable. They both lay down that there is neither complete constraint nor complete free will. God *creates* the capacity to do good or evil actions, and *knows* what the man is going to do (*Nukat*, 24).

In the *BHA* this is very clearly explained in Section IV on Allah's Justice, pp. 40-53. It is said that Ash'arī taught complete predestination.

Actions belonged to God only, not to the creature. Good and evil both come from God. But the Mu'tazilites, Zaydites and Imāmites believe that actions proceed from man (*BHA*, 43). Else how could responsibility be placed on the head of man ? And would not God be wanting in justice? It is thus clear that what was haltingly put forward by Ṣadūq, was supported by Mufīd and adopted in its entirety by 'Allāma-i Ḥillī.

It is important to remember that this was a moot point among the "orthodox" theologians as well, and even Ash'arī had to use the doctrine of foreknowledge as a means to explain his doctrine of predestination. "Allah had knowledge concerning things before they existed, from eternity" (*MC*, 211). Ṣadūq's doctrine, being apparently nearer the Ash'arite view, evoked the refutation of Mufīd. It is therefore to be expected that the Imamīya, while not entirely denying foreknowledge, would oppose the Ash'arite view and, on the basis of God's justice, give greater responsibility to man.

IMMORTALITY OF THE SOUL (Arts. 19, 20).—According to Ṣadūq, the soul of man is immortal. "And concerning the souls we believe that they were created for eternal existence and not for extinction" (*SC*, 49). Mufīd however is entirely against this view. He says that such a belief would lead to the doctrine of transmigration and would be opposed to clear texts of the Qur'ān and the doctrine of *ma'ād*.

Neither Wensinck nor the *BHA* discusses this question fully, but it appears that the nature of the soul and the spirit was discussed in great detail by later theologians, and the general view appears to be against the immortality of the soul or the spirit.[11]

The above two questions are of the utmost importance. Those which follow, namely, disputation, the Tablet and the Pen, angels' prayers and the descent of revelation cannot be placed on a footing of equality with them ; and yet they deserve a few pertinent observations.

DISPUTATION (Art. 11).—Ṣadūq entirely forbids discussion about *qaḍā* and *qadar* ; Mufīd objects to this categorical denial. First, discussion is prohibited if it leads to bad results ; but it is not forbidden to competent persons. Secondly, discussion is prohibited about the cause of creation and command, and not generally. Thirdly, a sincere quest after the truth is not forbidden ; only vain disputation is to be avoided. Mufīd thus engrafts many salutary exceptions on the plain and dogmatic view of Ṣadūq.

Islam, like Judaism and Christianity, condemns the rationalistic attitude, and this is unmistakably reflected in certain Sunnite traditions as well (*MC*, 54, 112). Tradition credits the Prophet with the view that communities which indulge in disputation will be destroyed ; for, ultimately, a stage will be reached when they will ask, "Here is Allah, the Creator of all things. But who created Him ?" (*MC*, 54).

THE TABLET AND THE PEN (Art. 16).—It is difficult to say how Ṣadūq arrived at the extraordinary doctrine that the Tablet and the Pen are angels. Neither Mufīd nor the Sunnite doctors agree to this novel proposition (*SC*, 44). Sunnite tradition has it that "the first thing Allah created was the Pen. Then He created the Throne and the Chair, then

11 *EI*. iii. 827-830.

a Preserved Table from a white pearl ; its upper and nether surfaces were of white hyacinth, its pen was light and its writing was light. Allah looks towards it every day two hundred and sixty times ; at every look He creates and causes life and death, He elevates and humbles, He raises some and brings others low."[12]

Wonderful as the descriptions are, it is still impossible to explain the doctrine of Ṣadūq, unless it be that, overpowered by a contemplation of these wonderful creations of the Almighty, he simply dubbed them angels.

ANGELS' PRAYERS (Arts. 37-39).—Ṣadūq holds the view that the food and drink of angels in Paradise consists of the sanctification and glorification of God (*SC*, 78-79,91). This idealistic creed apparently savours of the Christian view and Mufīd opposes it emphatically. He says firstly, that it is against the plain texts of the Qur'ān ; and secondly, that Shiites do not agree to it. Ismailis generally go still further. For them angels are Platonic ideas or abstractions of natural phenomena, and reward and punishment are to be understood in a purely spiritual sense.

In this respect the doctrine of Mufīd is more reactionary and literalistic. Ṣadūq's view may be compared with that of the Sunnite doctor 'Alī al-Qārī, "They are preserved from sin ; they never transgress the commands of Allah ; they are free from sex. In the *Jawāhiru 'l-Uṣūl* it is said that the angels have no share in the delights of Paradise, nor in the *visio beatifica*."[13] The *Nukat* and *BHA* do not throw any light on this question.

DESCENT OF REVELATION (Art. 40).—And finally, Ṣadūq's doctrine of revelation. The tradition books are full of stories how revelation came down to the earth : but neither *BHA* nor the *Nukat* lays down anything in the manner of Ṣadūq. Of the two, Mufīd is the less dogmatic and less literal ; and his views do not diverge greatly from the Sunnite doctrine.

The most systematic description of the various forms of the descent of revelation are given by Wensinck ;[14] we have dreams, visions, fainting fits ; but nowhere the peculiar details given by Shaykh Ṣadūq. And it would be interesting to make further inquiry into this question, and to track down the legend to its ultimate source. At the moment, however, I have no further information to offer.

We have now finished the consideration of the most important differences between these two early doctors of the Shiites, Ṣadūq and Mufīd. In conclusion we may consider the attitude of Ṣadūq regarding the Sunnites and their doctrines, and particularly the question of *barā'a* or *tabarra'*. In the Introduction of the *Shi'ite Creed*, I had pointed out that it would be dangerous to accept the opinions of the Sunnite heresiologists on the Shiite doctrine. The same can be said, with equal emphasis, about the Shiite doctors. The bitterness and fanaticism displayed by the Shiite theologians can best be judged by the way in which they ingeniously arrive at the conclusion that some of the Sunnites are infidels !

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12 *The Muslim Creed*, 162, citing al-Bayhaqī.

13 *Ibid.*, 200.

14 *EI*. iv. 1091-1093.

Beginning with the simple proposition that after the Prophet only 'Alī could be the righteous "leader" (*imām*) of the community, Ṣadūq gradually developed the following doctrines. And as Mufīd does not object to them, we may assume that he was in tacit agreement with him.

(a) Each prophet had a *waṣī* (*SC*, 92-93).

(b) 'Alī was the *waṣī* of the Prophet Muḥammad (*SC*, 123-124).

(c) After the Prophet, the most excellent of mankind are the twelve Imāms (*SC*, 95).

(d) Obedience to the Imāms is obedience to the Prophet ; and obedience to the Prophet is obedience to God. Similarly, disobedience (*SC*, 96).

(e) Devotion to and love of (*walāya*) the Imāms is a necessary article of faith (*SC*, 96n).

(f) He who fought 'Alī is an unbeliever (*SC*, 108).

(g) Denial of any one of the Imāms is tantamount to denial of God (*SC*, 107-108).

(h) Those who killed Imāms are accursed (*SC*, 101-102).

(i) The evil-doers are accursed and absolution (or dissociation) from them is an article of faith. This is the *barā'a* (*SC*, 105-106).

(j) "He who claims *imāmat*, not being an *imām*, is an accursed wrong-doer" (*SC*, 107).

(k) "He who ascribes *imāmat* to those who are not entitled to it, he, too, is an accursed wrong-doer" (*SC*, 107).

(l) Belief in Allah and His Messenger is not complete without seeking absolution as regards their enemies (*SC*, 109).

The twelve propositions set down above are enough to show the strength of feeling between the two schools even in the fourth century of the Hijra. In this connection it is most deplorable that doctrinal differences immediately invoke the wrath of the theologians to such an extent that a *fatwā* of infidelity follows almost automatically.[15] The doctrine of the law courts, which is also firmly established in the minds of the generality of Muslims—that the essentials of Islam are the belief in one God and the Apostleship of the Prophet—is too often conveniently forgotten or deliberately shelved.[16] One can only hope that this narrow-mindedness and fanaticism on the part of all concerned will gradually disappear, and comparative studies may be greatly fostered. For, today there is great need of a sober, critical and objective study of all the extant creeds for understanding, in its true perspective, the history of dogmatic theology and the evolution of belief in Islam.

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[15] M. Hamidullah, *Muslim Conduct of State* (Hyderabad, 1942), 52, citing *Fatāwā 'Alamgīrī*, shows that public denunciation of Orthodox Caliphs was considered as tantamount to apostasy.

[16] *Narantakath* v. *Parakkal* (1922) 45 Madras 986 ; Tyabji, *Muhammadan Law*, 3rd edition, art. 9.

GEOGRAPHY AS A UNIVERSITY SUBJECT

By

PROFESSOR B. S. SHESHGIRI, B. AG., M. SC. (CANTAB.), B. SC. (LOND.),

Lingaraj College, Belgaum

MAN is a social animal to a greater or less extent. Even in the most backward areas like the Hot Deserts, the Equatorial Forests and theTundra Regions human beings live together in small communities helping and co-operating with each other, although many of them sometimes quarrel or fight amongst themselves. As civilization advances and people of different groups, communities, countries and races come in contact with each other the social sphere is expanded and some sort of endeavour is made to understand other people rather than pick up a quarrel with them. Communications between different peoples become frequent ; easy and quick means of communications develop ; commodities are exchanged ; there is a quick turn-over of raw materials into finished articles ; and those who do not consider the whole humanity as one large community are considered as backward people. At the present time this is the case to a great extent. The world is an inter-related whole and incidents in one part have their reactions in other parts. When this is so it is the duty of every intelligent man to study critically and understand the features of the environments in different parts of the world and see how they control or influence the material and the spiritual lives of the people there. It is very instructive to learn about the history of the different peoples and how they slowly or quickly evolved from the original to the present status. The knowledge of the occupations and the habits of peoples, their social and political structure, their faiths—religions and festivals—and the influence of the surroundings on all these is not only useful from a material point of view but also gives a correct perspective to judge the achievements of one's own people as compared to those of the others. It is also instructive and interesting to study the development of one region by the peoples of different degrees of civilization and culture at various times. Such a study gives a broad knowledge of the world and is useful to plan for the future development of one's own country on proper lines.

When it is agreed that the above studies are useful we are to seek for a subject which deals with them in detail. A little thought convinces everyone that the science of Geography is a subject dealing with the above details.

We may examine what Geography is and where its place is in general education. Though the meaning of the word Geography is "the description of the earth" the subject matter of Geography does not stop at a mere description. It used to be a mere description or even worse than that at one time : it was merely a "where and what" Geography—a rote method of recitation of capes and bays, rivers and plains, lakes and towns and so on,—in other words, a jumble of unconnected and disconnected

facts without any reference to analysis, correlation and synthesis. The subject matter as well as the concept of Geography have been changed from about the beginning of this century in Western European countries and America. To India the modern concepts have reached only in recent times. Young men and women, not more than twenty-five to thirty years of age, tell of their school days when Geography was the driest and the most uninteresting and difficult subject. They were made to memorise the names of towns, lengths of rivers, areas of countries, distances between places, heights of mountains and depths of oceans, and blurt out these at the time of examinations. At best the students were required to run to a political wall map and show the position of a town, river or lake. Such Geography is undoubtedly uninteresting and difficult, and is practically quite useless as an informative, educational or cultural subject.

According to the modern concept mere names and statistics occupy a secondary place. More importance is rightly given to the central figure—*man*. The old definition of Geography as the description of the earth has been discarded and new and comprehensive definitions, such as "the science which treats of the relation between the earth and man," "the science which treats of the influence on man of local conditions and space relations," or "science which investigates the condition of the macro-organism and the space relations of the component parts" have been given. Its function has been defined by one eminent geographer as being "to train future citizens to imagine accurately the condition of the great world stage and so help them to think sanely about political and social problems in the world around." Thus Geography is not merely a descriptive science or a simple science of distributions. It deals of man in different parts of the globe and how his life and degree of civilization are controlled and influenced by the environmental factors. It also deals with the attempts by man to overcome and modify the effects of the surroundings and the degree of success achieved by the different peoples in the same type of environment or even the same area.

We may take an instance. Geography teaches about the environments of Malaya, *viz.*, its physical build-up, climate, vegetation, geology including minerals and also how the local groups of people are differently influenced by these factors. The primitive of the Malayan high forest is still a hunter and food gatherer and lives on the natural products of the forests. The more advanced people living near the coast lead an agricultural life (cultivation of rice), again suited to the environment. A few are engaged in mining and fruit culture. It required the genius of a Western European of a higher culture and inventive capacity to utilize the same environment for the growing of rubber trees which were not found in large number naturally. The environmental conditions were similar to those of the native place of rubber. Still rubber was not abundantly produced in Malaya. Rubber plants were carefully brought from the Amazon Lowland, planted in Malaya on land obtained by clearing forests with mechanical power, and the result to-day is that Malaya and the neighbouring islands of the Dutch East Indies together produce about ninety per cent. of the world's natural rubber.

Some people relegate Geography to a secondary place because, they say, Geography is a subject which simply makes use of bits of pure sciences

like Geology, Physics, Chemistry, Biology, Sociology, Economics, etc., and has itself no independent existence. Modern geographers definitely admit that the science of Geography takes the help of other sciences, pure and applied ; but they are as definitely of the opinion that Geography is as much an independent science as any other. We may examine this view.

The study of Geography involves the study of environments on the one hand and the reactions of human beings to these environmental factors on the other. Thus it is just like a bridge which connects the physical or pure sciences and the human sciences. We find no other science which does this essential and useful work. Work of Geology is over when the constitution and the surface features of the earth (morphology) together with the minerals are described. Geography goes further and shows how man reacts to the various land forms and when, where, why and how minerals have been utilised to satisfy man's needs. Meteorology—Physics of the Atmosphere—describes the principles about temperature, pressure, humidity, rainfall, etc. Climatology goes further and states the average conditions of the above factors in the different parts of the globe at different times. Thus the day to day conditions of weather are analysed, correlated and synthesised to give the general conditions of climate. Like climates are grouped together. It is left to the science of Geography to study the correlation between the various climates and vegetation, natural and cultivated, and finally between these two and animals including man. Incidentally it should be noted that the science of Biology and especially Ecology is surely made use of. Chemistry is extremely helpful for the study of the phenomenon of denudation. Anthropology describes the characteristics of human races and related facts. Archaeology studies man's cultural and other achievements in prehistoric and historical times. History is a chronological account of the most important happenings in the world affecting a large number of peoples. Sociology is a part of human ecology which concerns itself with the interaction of human groups and individuals. Economics deals with the distributions, occupations, means of communications, industries, etc., at different places and times. Politics deals with the forms of governments, national and international policies, boundaries, etc. Geography tries to explain the anthropological facts, historical events, economic distributions, social groupings, political policy and so on.

It is clear that the subject of Geography keeps man at the centre and studies how his life is being influenced by the environment and how he in turn influences the surroundings. Examples illustrating the latter statement, *viz.*, the influence of man on environment are, though few, important and have affected the lives of many people. The effect of the introduction of rubber plants in Malaya and the Dutch East Indies has already been mentioned. Naturalization of American Upland cotton in some parts of India and other countries, introduction of cattle and sheep into Australia and New Zealand, conversion of large tracts of deserts and semi-deserts into fertile lands by irrigation, growing large quantities of cereals in Prairie lands and Steppes, and introduction of tea and coffee in forest lands of the tropical belt are some of the outstanding examples. By his own continuous work man has modified environments in these cases to a large extent. Day to day modifications are going on throughout the world, though in a small degree. Thus the study of the relation of man

with his environment is essentially the subject matter of Geography and no other science treats this subject matter.

Questions are often asked about the place of Geography in education ; why it should be taught at all in schools and colleges ; and whether it helps to make human beings better citizens of the world. Before attempting to answer these questions one should firmly understand the objects of education and then see whether a study of Geography fulfils these objects.

Education may be said to fulfil three purposes broadly, *viz.*, cultural progress of human society, training of the mind of an individual human being and providing a means of livelihood. We may examine these factors.

The purpose of education is to give scope to the latent powers of a new individual and to put these powers into harmonious relationship with his or her environment. The environment of any individual consists of two aspects, *first* the human environment with which the individual comes in contact and is most intimately associated, and *second* the natural environment which influences the human environment. Both these aspects are the subjects of study of the geographical science.

Every human being when he is properly encouraged craves for obtaining knowledge from the ends of the earth. This craving is natural, and one always finds people extremely interested to listen to stories depicting the life of other people, to learn about conditions elsewhere and thus to illuminate their own minds. Even the most educated person, when he visits a museum or an exhibition, likes to see and hear about things he did not know before and thus gather knowledge. This characteristic is inherent in man. Geographical study is one of the methods by which the craving for knowledge can very well be satisfied. It gives him an idea of the enormous extent of control or influence that environment has on the life of man.

Acquisition of a deep knowledge gives in turn a contented mind, a mind which is able to place the possessor in correct perspective with reference to others, neither exaggerating nor diminishing his own capabilities and achievements. The ideas of superiority and inferiority obtain new and dignified values and the result is a respect for and an understanding of the lives of other people. Man begins to think in terms of his neighbour, who is not only his own countryman but everybody on this earth. He stops from looking down upon a negro or considering himself superior to all others. He begins to understand his own drawbacks and at the same time is able to put correct value on his own achievements. Principles of right and wrong take a firm root in him. His mind becomes prepared to do all he can for the uplift of the less advanced people and to fight for the rights of every human being irrespective of colour or nationality. Such is the attitude of a trained mind, a reformed mind, a cultured mind, and a study of Geography helps to form such a mind.

Again, in the study of Geography all kinds of observations are made regarding the surface features of the earth, temperatures, rainfalls, activities of man, and so on. These give a training to the mind and make it alert, thus helping to develop the faculties of both the young and the old. People are encouraged to take keen interest in the things surrounding them and make enthusiastic human beings in the end. Many of these

observations are to be recorded and this habit of recording gives a further training to the mind and a permanency to the knowledge. Emotions of the mind are better expressed than suppressed : if suppressed they may do greater harm than when expressed. Arguments, discussions, observations, records and deductions are surely better forms of expression of emotions than the inhuman methods like wars, feuds and strifes.

The study of Geography requires a number of excursions, campings and walks which are conducive to good health and infuse a spirit of co-operation, an idea of self-help and a study of minute differences in the lives of small groups of individuals.

A man with a vast geographical knowledge is in a better position to know other people's requirements. A study of the tastes of other peoples, their manners and customs is of immense help for success in business. A geographical knowledge is useful and in many cases essential for the success of an industrial concern. It is useful to administrators who are responsible for future planning.

Geography has been taught in schools in all parts of the world, but until the whole conception of the subject changed from the "where and what" Geography of disconnected facts to the modern anthropo-centric concept, Geography was a dull and dry subject. Teaching was a burden on the mind of the teacher and learning a tax on the brain of the pupil. Since about the beginning of this century and more actively after the Great War, the schools of all the civilized countries have been staffed with trained teachers, and a keen interest is created in and evinced by the students for the subject. In India, even though the changed concept has been accepted by a large majority of schools, a few still follow the old method. This is probably due to the lack of a sufficient number of trained teachers in the subject, which is obviously due to the neglect of the subject in Indian Universities. We hope that the few schools which still follow the old method will abandon it in the near future.

The centres of higher education, *viz.*, the colleges and universities and the institutions that are responsible for the regulation of the educational system of a country should realise the importance of the subject and give a guidance to schools and other small teaching institutions. Schools look for guidance from the centres of higher education which should not only advise the former in the selection of subjects and the preparation of the curricula but also be able to provide facilities for a proper training of the teachers who should have a thorough knowledge of the subjects. What we actually find in this country is that, though Geography is a compulsory subject, it is not given an independent footing in some University Entrance Examinations. The Bombay University has been wavering for a long time. For some years Geography was combined with History in one paper set at the Matriculation Examination. For a few years it was made an independent subject of study and a separate paper was set. At the present time it has been yoked with History, and degraded to a section of forty marks out of one hundred. If this is the reception given to the subject at the University Entrance Examination, how can one expect the teachers and the taught at the schools to take a keen interest in the subject ? Ideally, the teaching in schools should be such as to educate the minds of the pupils and not merely to train them for examinations. Yet as the pupils are very young and do not know their own responsibilities

on account of their undeveloped faculties the examination and not the cultural point looms large in their minds. The teacher also—an overworked, low paid individual—looks to the completion of the curriculum. This fact should be considered while preparing a curriculum. Repeated requests have been made by geographers but the status of the subject has not been improved. Hence a student who enters the portals of a college is very ill-equipped with the general knowledge of the modern world which is a *sine qua non* and which is imparted by no other subject but Geography. Detaching the subject from History and making it a separate two-hour paper of seventy-five marks is not, really speaking, an impracticable proposition. Similarly, History also may have an independent existence with a two-hour paper of seventy-five marks.

We may now consider the place of the subject in colleges and universities. In all parts of the world there was naturally an opposition to the old type of Geography, both as regards the subject matter and the method of teaching. Therefore the subject did not find a place in the curricula of colleges, universities and other institutions imparting higher education. The evolution of the modern concept has its roots in Germany where Humboldt and Ritter created a School of Geography four generations ago. This school keeps its high standard and has produced eminent geographers like Ratzel and Suess. Similar work was done by Reclus and Vidal de la Blache in France, and to-day the French geographers command a great respect all over the world. De la Blache is called the father of French geographers and his monumental works of Regional Geography are not only useful to geographers but also are referred by geologists, economists, anthropologists and sociologists. Later on the thread was taken up by British and American geographers. The names of Herbertson and Geddes stand out amongst the former. The subject was introduced in most of the universities of the civilized countries of the world. In the British Isles the subject can be studied from the intermediate to the post-graduate stage. Oxford has a School of Geography of Herbertson fame. In Cambridge it is a subject for the ordinary Degree as well as for the Tripos. In the London University it can be pursued from the intermediate to the honours course, and the same is the case in the other British universities. It occupies an independent position in the universities of the United States of America and the British Empire except in some universities of India. In the Imperial University of Tokyo there is a three-year course in Geography.

The position of the subject is therefore secure in other universities ; but the same cannot be said of the Indian universities. Undoubtedly, the modern concept of the subject was grasped by many Indian educated men very recently ; even then it is difficult to see why the subject should not be given an equal status with other subjects and introduced in all colleges of this country. Educated people know that Geography is an important subject for the Indian Civil Service Examination. They agree that this Examination is one of the toughest and tests the all-round knowledge of a candidate very thoroughly. Yet the same civilians and other educationists who, in a variety of ways, influence the working of a university in India, do not see their way to give a status to the subject by introducing it in the syllabuses of the Bachelor's and the Post-graduate Degrees. It is really very anomalous. In these days complaints are heard everywhere that education in the Indian universities is still old fashioned, espe-

cially in the Arts subjects, and is planned to turn out people for the lower services. Men responsible for the selection of candidates for public services complain that the latter utterly lack in geographical knowledge.

Some universities in India have introduced the subject. In the Madras University Geography can be studied for the B.A. Degree and there is also a Diploma course of one year for teachers and others. The Mysore University has included this subject both in the Arts and the Science groups of the Bachelor's Degree. Similarly, the Universities of Agra, Allahabad, Andhra, Annamalai, Calcutta, Delhi, Nagpur, Osmania, Patna, Punjab and Travancore have courses for the Intermediate Examination in some cases and for Degree Examination in the Arts and the Science branches in others.

In the Bombay University there was a great agitation for a long time and finally Geography was recommended by the Degree Reorganisation Committee as a subject to be included in the Degree courses of both the Arts and the Science Faculties. In the year 1937 the University introduced the subject in the First Year Arts syllabus as an alternative to Mathematics or World History. Since then the matter has been raised in the Senate more than once and yet the University has not seen its way to introduce the subject in all the higher classes. It is difficult to understand as to why a premier educational body of the Presidency is showing a step-motherly attitude towards this subject. We hope that the omission will be soon rectified. At the present time Geography is a subject only for the First Year Arts Examination while the alternative subjects—Mathematics and World History—are subjects for the B.A. Examination. On the Science side it has been introduced as a subsidiary subject for the B.Sc. Examination but does not find a place in the syllabuses of the lower Examinations. This is the reason why students are not enthusiastically selecting the subject, and if selected may not be studying the subject critically. For some time there was a lack of trained teachers of Geography in the colleges. Since 1932 a good number of people have obtained training in the subject at the hands of some of the well known geographers. To-day there is at least a sufficient number of trained people who are competent to handle the subject satisfactorily. Is it not time for the University of Bombay to include the subject in the syllabuses of the Degree as well as the Post-graduate courses of both the Arts and the Science Faculties ? It is a hopeful sign that the subject has been recently introduced as a subsidiary subject for the B.Sc. Degree from June 1943. As it is quite evident that the subject of Geography is important from the educational point of view it is the duty of all universities to include it in the undergraduate syllabuses and to provide facilities for research in a University Department of Geography.

These lines are not written merely as a protest ; they are also meant to show the extreme usefulness of the geographical study to an average educated human being. The study is more useful to Indians because they, in general, do very little travelling in their leisure time to see things first hand. In many public examinations and *viva voce* the examiners are surprised at the ignorance of geographical knowledge shown by candidates who hold Bachelor's and Master's Degrees. Even in India Geography is a compulsory subject for most Public Service Examinations. Is it too much to ask for a status to this subject in the Bombay and the other Universities of India ?

BOOK REVIEWS

Languages and the Linguistic Problem. By S. K. Chatterji. Oxford Pamphlets on Indian Affairs : No. 11. Pages, 32. As. 4.

THE linguistic problem has much of its difficulty due to sentiments attached to it more than to its inherent complexity. The necessity, therefore, of dealing with it with dispassionateness and without bias is all the more urgent, particularly when the intention is to state it for the understanding of the general public. In this respect Dr. Chatterji has succeeded eminently in this booklet of his. Well-known among linguists as an erudite scholar of wide and comprehensive grasp for his *Bengali Language*, the first scientific work dealing with the whole of the Indo-Aryan field in its endless details, Dr. Chatterji has shown himself equally successful in general exposition of linguistic problems for educated classes in his *Indo-Aryan and Hindi*, and now he has proved his ability in the really difficult task of explaining to the general public the outstanding problem of a national language for the whole of India. His solution of the problem is quite clear and easily understood. He proposes that a simplified form of Hindi should be adopted for this purpose; its original vocabulary should be exploited to the fullest and in case of deficiency Sanskrit should be drawn upon, with the reservation of Arabic and Persian elements for matters of Islamic culture; it should be written in Roman script with a few simple modifications but the alphabet is to remain essentially Devanāgarī both as regards its arrangement and sounds. This language is to be treated as a second language by the side of the mother-tongues of the different provinces without any attempt of supplanting them. In order to clarify the problem, the author has incidently given a very readable summary of the growth of the different language-families current in India and has traced clearly the growth of the Indo-Aryan provincial speeches in broad outline, in order to make evident the importance of the languages of the Madhyadeśa and the central position of Hindi. He has also removed a number of misunderstandings usually associated with the language-problem in India and his ideas like, that nationality has no intrinsic relation to the uniformity of language or that a simplified form of Sanskrit may well be used as an interprovincial language, will give many to think, the ideas coming as they do from a linguist of his reputation. The catholicity of his mind can best be judged by the fact that, though a linguist by profession, he warns his readers not to make the language problem of India more complicated or regard it as more difficult of solution than it really is. Though all may not agree with all the details of his solution of the problem, it is certainly worthy of a serious trial, which should not be difficult with a little spirit of accommodation on the part of the public.

A. M. GHATAGE

A Bibliography of The Rāmāyaṇa. By Prof. N. A. Gore, M.A. Published by the author at Poona, 1943. Price Re. 1/8.

THIS excellent booklet by Professor Gore of the S. P. College, Poona, is sure to receive an enthusiastic welcome from all serious students of the Rāmāyāṇa. Books like these serve a double purpose ; they help to satisfy the needs of a specialized study in the case of one who has already undertaken it ; but what is more important, even a cursory perusal of them inspires in a student a strong desire to undertake an intensive study of some specific problem connected with their subject matter. The material for this Bibliography has been carefully prepared and methodically presented. Different editions of the Rāmāyaṇa, both critical and uncritical, are first described. This is followed by a description of its translations into English and other European and Indian languages. A few important abridgements and epitomes in English, Sanskrit or other languages are mentioned next ; and finally all important books of general criticism of the poem as well as articles of a similar nature appearing in the various magazines and periodicals are given. The matter under each head is alphabetically arranged and in many places appreciative or informative remarks are added in rectangular brackets under the different entries. The remarks are a sufficient indication to show that the author was not working in a purely mechanical manner.

A few extracts from books of general criticism are added in Appendix II. At first glance, one expects that these extracts would be restricted to older books which are not now available and to books which are written in a foreign language. But no such definite plan is evidently kept in view by the author and the extracts are given at random *for the use of the University student*. The author is conscious of this and other imperfections of his work as is clear from his preface. Evidently, there is a struggle in the author's mind between the Note-maker and the scholar, and we earnestly hope that the scholar in him will soon get the upper hand.

H. D. VELANKAR

Jadivasabha's Tiloyapannatti (An Ancient Prākrit Text dealing with Jain Cosmography, etc.). Authentically edited for the first time by Prof. Dr. A. N. Upadhye and Prof. Hiralal Jain; Part I. Published by Jaina Saṇskṛti Saṁrakṣaka Saṁgha, Sholapur, 1943. Price Rs.12.

THIS is an important ancient Prākrit text mainly dealing with Jain Cosmography composed by Yati Vṛṣabha, who is an old writer of the Digambara school of Jainism. The present edition is based upon only two Mss. and contains the first four chapters out of a total of nine. A literal Hindi translation is given below the text. It is evident that the Mss. material available at present is insufficient for a critical edition of the text ; yet the editors may safely be relied upon for not taking too many liberties with their Mss., in their enthusiastic attempt to give the reader 'a meaningful text.' No serious objection can be taken to the procedure adopted by the editors who give the emended form of a reading in the body of the text, giving the form warranted by their Mss. in the foot-notes, even though this is not strictly correct. We hope the remaining chapters of the work will follow soon.

H. D. VELANKAR

Jaina Sāhityā aur Itihāsa (in Hindi). By Pandit Nathuram Premi. Published by The Hindi-Grantha-Ratnakara Karyalaya, Hirabag, Bombay No. 4, April 1942. Price Rs. 3.

PANDIT NATHURAM PREMI is a well known Hindi writer who has specialized in the study of Jaina literature, particularly of the Digambara school. He has been writing articles for the different Hindi magazines devoted to the study of Jainism and its literature for the last thirty years and more. He is a careful collector of facts and his deductions are generally logical and reasonable. The present volume contains 48 articles originally published in the above mentioned magazines or in the introductions to the Jain texts published by him from time to time. He has been the general editor of the Manikchandra Digambara Jain Grantha Mala for a very long time. The articles, which are here revised and brought up to date are a veritable mine of information gathered from various literary sources, with great patience, impartiality and judiciousness. We strongly recommend the book to all lovers of Jain literature. It contains valuable information about over forty ancient authors or works of Jainism.

H. D. VELANKAR

Bhānucandracaritra. Composed by Siddhicandragaṇi. Critically edited with an elaborate introduction by M. D. Desai, M.A., LL.B. Published by the Sañchālaka, Siṇghī Jaina Granthamālā, Ahmedabad—Calcutta, 1941.

THIS is an historical poem composed in Sanskrit verse by Siddhicandragaṇi, a Jaina monk of great repute living at the court of Emperors Akabar and Jehangir. The hero of the poem, Bhānucandragaṅi, was his Guru and was a great favourite at Akabar's court in particular. The poem is highly valuable because the author has described in it many events in the life of his Guru with the help of an intimate and first-hand knowledge, and these events throw an interesting and additional light on the tolerant attitude of the two emperors in matters pertaining to religion. The present edition of the poem is based upon a single Ms. from Bikaner, and this is a little unfortunate from a pure scholar's point of view.

In his learned introduction, the editor gives first a brief but lucid account of about 25 Jaina teachers either living or casually honoured at the court of Emperors Akbar and Jehangir and then a detailed summary of the poem, supporting the historicity of the events mentioned in it by means of independent and contemporaneous evidence given in the foot-notes. A genealogical list of Bhānucandra's pupils is given hereafter, followed by lists of works of Bhānucandra and Siddhicandra. In Appendix I, extracts (merely beginning and end, and this too not in all cases) from these works of the two authors are given, while Appendix II contains an English translation of ten relevant imperial Firmans of the two Mogul emperors, namely, Akabar and Jehangir.

The editor is a well-known writer in Gujarati on several topics pertaining to Jaina history and literature, the most important and valuable of his works being the *Jaina Gurjara Kavio* in five volumes.

H. D. VELANKAR

1. *Śrī Pāñcarātra Rakṣā of Śrī Vedānta Deśika.* Critically edited with notes and variant readings by Pandit M. Duraiswami Aiyangar and Pandit T. Venugopalacharya. Published by the Adyar Library, Adyar, Madras, 1942. Price Rs. 4/8.

2. *Caturdaśalakṣaṇī of Gadādhara*—With Three Commentaries; Vol. I, Lakṣaṇas 1 & 2. Published by the Adyar Library, Adyar, Madras, 1942. Price Rs. 4/8.

THESE are two Sanskrit texts recently published by the Adyar Library, Adyar, Madras, as Nos. 36 and 38 in their Series. The former is a treatise on the tenets and special rites and rules of the daily religious conduct of the followers of the Pāñcarātra Āgama. It is in three chapters, and was composed by Vedāntadeśika, also called Nigamāntaguru, who lived in the 13th and the 14th centuries of the Christian era, and wrote several works in Sanskrit and Tamil. He was one of the greatest among the Vaiṣṇava Ācāryas of the Viśiṣṭādvaita school and his name stands second only to that of Rāmānuja. The text of the present work is based on five printed editions and six palm-leaf Mss. The introduction in English and the Bhūmikā (in Sanskrit) together give a brief but clear account of the three classes of the Āgamas and their distinction from the Nigama or the Vedas. They also give some information about the author and try to explain the meaning and derivation of the word Pañcarātra.

The second work is, as we are told, 'the first instalment of a series of Nyāya works which the Library proposes to publish.' It contains the first two Lakṣaṇas out of the fourteen which constitute the Caturdaśalakṣaṇī of Gadādhara. Gadādhara's work itself is a commentary on Raghunātha Śiromaṇi's Dīdhiti, which in its turn is a commentary on the Tattvacintāmaṇi of Gaṇgeśa Upādhyāya, who started a new phase of the development in the Nyāya-Vaiśeṣika system of philosophy in India in the 12th century A.D. The text of Gadādhara is based on three Mss. and three printed editions of the work. It is accompanied by three commentaries on it, printed one at the end of the other in the book, very properly, since they are not intended to explain the text, but rather to elaborate and amplify its arguments. The printing and get-up of the books is excellent.

H. D. VELANKAR

Descriptive Catalogue of Sanskrit Manuscripts in the Adyar Library, Volume I—Vedic. Compiled by K. Madhava Krishna Sharma, M.O.L., under the supervision of Prof. C. Kunham Raja, M.A., D.Phil. (Oxon). Introduction by the latter. Adyar Library Series—No. 35. Pages xxxvi+415. Price Rs. 15.

EVERY attempt to bring to light the vast treasures of Oriental learning lying hidden in the form of Mss. deposited in several libraries, private and public, is to be warmly welcomed, particularly because it is thus that a path is paved for the re-construction of the history of the past by supplying the various tantalising lacunae. It is these treasures, when properly approached, that reveal to us not only the glorious traditions of the past, but also the various vicissitudes through which the society had to pass and out of which the present has

emerged. It is by a right understanding of the past as well as the present that we can hope to shape our future. Anything, therefore, that is calculated to throw light on the past is certainly a matter for careful study and observation. It is with these feelings that we welcome the first volume of the Descriptive Catalogue of Sanskrit Mss. in the Adyar Library, compiled by Mr. K. M. K. Sharma who herein has described 1103 Mss., all Vedic, classified into six different sections.

The four Vedas have four sections, one for each Veda, wherein are noticed Mss. of the Saṁhitā, and the Pada Pāṭhas, the Brāhmaṇas, and the Āraṇyakas in serial order. This was the plan of classification adopted in the catalogue in two volumes published in 1926 and 1928; and the compiler has only retained the original plan in the present compilation. The fifth section, covering Nos. 530 to 709, is called the Miscellaneous section. Works like the Puruṣa-sūkta or the Devī-sūkta or the Manyu-sūkta which can be definitely assigned to one of the Vedic Saṁhitās have also been included in this section along with others like the Nava-graha-mantrāḥ or the Abhiśravaṇa-mantrāḥ which are really of a miscellaneous character being put together for ritualistic purposes from different sources. The compiler has carefully traced the works of the former type to their respective Saṁhitās in almost all possible cases; and there would have been nothing unnatural if all these were placed in the sections allotted to these Saṁhitās. The work described under No. 48, on the other hand, might better have been relegated to the Miscellaneous section. The last section contains a description of about 400 Vedāṅga Mss. promiscuously described in an alphabetical order. A further sub-classification of these into smaller sub-sections, one for each Vedāṅga, would surely have enhanced the utility of this section.

That the collection is important and that it has been ably described is obvious. Every section contains some important and interesting Mss. and works; and the quotations subjoined under the description go a long way to rouse the curiosity of even a casual reader. Interesting problems have sometimes been discussed and detailed references to articles and papers are also given for the benefit of the curious reader. A brief statement of the results arrived at on such problems in these papers or articles, however, would have been more helpful to the casual reader.

In a work of this type it is but natural that errors both of commission as well as of omission should creep in. And a few such have found their way into the present compilation also in spite of all the care exercised by the compiler. Thus the name of the work under No. 726 should be Avarṇi-dīpa and not Avarṇa-dīpa (*cf.* the first verse quoted there, and also No. 727 and the first verse quoted under No. 988). The author of the Nāradīya-śikṣā-vivaraṇa is Bhaṭṭa-Subhākara according to the colophons quoted under No. 865 and not Bhaṭṭa-Sobhākara as stated by the compiler apparently through oversight. Sūrāvadhānin is to be identified with Sūrya-nārāyaṇa of Velimakanyapura (or Valmīkapura; *cf.* the verse and the colophon under Nos. 1002 and 1005). Thus the expression Velimakanyapura-sūrāvadhānin (*cf.* No. 933) has to be understood as giving the residence and the surname of the author. In view of the surname Avadhānin occurring in Nos. 734 and 813, it is also possible that Sūra in the expression Sūrāvadhānin stands for Sūrya-

nārāyaṇa which is the real name of the author. Yet see the colophon under No. 1005 where we get the name of the author as Sūrya-nārāyaṇa Sūrāvadhānin. No. 715 is really a Ms. of the Sapta-lakṣaṇa as is clear from the colophon at the end. Sapta-lakṣana is the name of a work consisting of seven parts for the names of which see the first verse quoted under No. 988. In this collection there are several Mss. of these various parts of the Sapta-lakṣaṇa and all these might better have been brought together under the main title Sapta-lakṣaṇa. Chandoviciti again is once the Chandaḥ-sūtra of Piṅgala (*cf.* No. 795) and at another place it is a portion of the Nidāna-sūtra of Patañjali (*cf.* No. 796). This latter should have been described under the title Nidāna-sūtra only, particularly because no less than six Mss. have been described under that title (*cf.* Nos. 868-873).

But such inaccuracies are only too few to mar the value of this work, which lies in the copious extracts from works under notice and also in the various references to important papers and articles. These supply us with much valuable information and hence deserve a careful study. The compiler has done his work quite judiciously and has laid research scholars under deep obligations. We should, however, have felt still more obliged if he had taken the trouble of stating in brief such information as could be gathered from these Sanskrit quotations. At least the principle of underlining the important portions from the quotations could have been easily followed without any additional pressure on space or energy. No. 447, for example, contains the description of a work of Bharata-svāmin who, *inter alia*, declares that he composed his work during the reign of the Hosala king Rāmanātha. At least such highly important pieces of information ought to be specifically noticed by the cataloguer although he may not go even further and give the date of the king and thus help to fix the date of the author.

The principle of noting down the authorities referred to in the works under notice has been observed only once (*cf.* No. 42, p. 12). But the names of these authorities ought to have been given, not according to the folio where they occur, but according to the alphabetical order.

Special interest attaches also to the scholarly introduction by Prof. C. Kunhan Raja who has very ably pleaded in favour of Oriental Studies in general and a study of the Mss. in particular. To him as also to Mr. Sharma our hearty congratulations are due for the service they have rendered to Oriental Research by bringing out the present volume.

G. V. DEVASTHALI

Progress of Indic Studies, 1917-1942. Government Oriental Series Class B, No. 8. Published by Dr. R. N. Dandekar, Honorary Secretary, Bhandarkar Oriental Research Institute, Poona 4. Pages 2+ii+406. Price Rs. 8.

DR. DANDEKAR, the energetic scholar-secretary of the Bhandarkar Oriental Research Institute, deserves our warmest congratulations for the great task he has so ably achieved in bringing out *The Progress of Indic Studies, 1917—1942* which is sure to help the reader to get a clear idea of the work that has been done during the last twenty-five years in several branches of Indology and thus create in him a living

interest in Indology in general and some branch or branches thereof in particular. The first half of this volume is taken up by five different papers surveying the work done in the five branches of Indian literature, *viz.* Vedic, Iranian, Epic and Puranic, Prakrit, and Classical. Four more deal with Archaeology, Ancient Indian History, and Manuscript Studies ; and the three that remain concern themselves with Linguistics, Sociology and Indian Philosophy respectively.

Even a cursory perusal of the very interesting and inspiring contribution of Dr. Dandekar covering no less than sixty-six pages is enough to give its reader a fairly good idea of the bulk and the variety of the Vedic Research in all its aspects. But the real interest of this paper from the point of view of the general reader lies in the fact that it very lucidly sets forth the general results that have been achieved by different scholars on different problems connected with the subject, and shows how this line of research is holding out signs of good development.

Dr. Pusalkar's *Twenty-five Years of Epic and Puranic Studies* is again a very studied paper in which he has conscientiously taken note of almost everything that has been published in connection with the Epics and the Purāṇas, and thus supplied the reader with almost every new idea that has thus far been presented to the public by scholars working in the field. In doing this it was but natural that prominence should have been given to the monumental work of the Critical Edition of the *Mahā-Bhārata* in general and the epoch-making contribution to Textual Criticism made by the late Dr. Sukthankar in particular. A perusal of this paper is sure to leave its reader well informed regarding the work done by scholars in connection with the Epics (including the *Bhagavad-Gītā*) and the Purāṇas.

More interesting still is Dr. Ghoshal's *Greater Indian Research* which helps to widen our vision by putting together what valuable results in the field of Indology have been achieved by scholars not only in India but also outside India. As we go through these highly interesting and instructive pages a consciousness of the wide influence that India and its scholars once exercised beyond the Indian soil dawns upon us ; and though being painfully made aware of the sad contrast it presents with the modern state of things we yet feel inspired to try our best to attain that glory which it was once our proud privilege to enjoy. This paper is, indeed, packed with information which every lover of India would feel elated to possess.

Mr. Chakravarti in his *Study of Manuscripts* has rightly suggested that the work of search and collection is as important as the work of conservation. Very little work seems to have as yet been done in this direction in the field of Vernaculars ; and it may be suggested that scholars should direct their attention to that field also particularly because of its importance for the reconstruction of our history during the past few centuries in all its aspects.

It is, indeed, a great treat to go through these 406 pages contributed by different scholars adept in their respective branches of Indology. It is impossible for a general reader to get even a cursory acquaintance with the work done in the various branches of Indology. Such volumes as the one brought out by Dr. Dandekar, therefore, are certainly wel-

come as an effective means of spreading acquaintance with and inspiring interest in Indology in its various branches. We, therefore, again very heartily congratulate Dr. Dandekar for having brought out such an important volume and laid the general reader no less than the research scholar under deep obligations.

G. V. DEVASTHALI

An Approach to the Rāmāyaṇa. By Dr. C. Narayana Menon, M.A., Ph.D., D.Litt. Published by S. C. Guha, Gandhigram, Benares, 1942. Pages, viii+27+iii.

SINCE the last millennium, the *Rāmāyaṇa* has been influencing the lives of the Indians by inspiring them to follow the ideal of Rāma ; the story has travelled beyond India in the early centuries of the Christian era and has enchanted Greater India, Indo-China, Tibet, etc. Though the person named Rāma is dead, the word Rāma itself is still living, and has rendered signal service to distressed humanity by strengthening shattered nerves and broken hearts, inspiring confidence and restoring peace and good will on the earth. *Tulasi Rāmāyaṇa* is exerting phenomenal influence over the Northern India. It is a good sign that Dr. Menon has brought his New Approach for the educated public when the modern youth is looking to the West for guidance and inspiration.

The author regards that the *Rāmāyaṇa* represents a synthesis of the cults and cultures prevalent in different parts of India, and also as the first poem of Akhand Hindustan. He has consulted the *Vālmīki Rāmāyaṇa, Adhyātma Rāmāyaṇa* and *Rāmacaritamānasa*, which differ widely in their aspects but the groundwork is the same. Dr. Menon shows that imaginative identification is necessary to understand literature.

The *Deharāmāyaṇa* is perhaps the most authoritative interpretation of the *Rāmāyaṇa* according to the author. The *Rāmāyaṇa* is the dynamic Veda and is a symbolic presentation of the integration of mind through the resolution of conflicts. The surrender of the will of the reader to Rāma is essential, and the *Rāmāyaṇa* cuts at the very root of fear by showing that all are Rāma. In these days when the world is reverberating with news of devastating wars the world over, the author prescribes the panacea of *Rāmāyaṇa*, and states that when Rāma is realized men cannot fight among themselves.

Dr. Menon's views regarding the teachings to be derived from the *Rāmāyaṇa* will receive universal acceptance. According to him, the *Rāmāyaṇa* shows that blind obedience to authority is not the ideal ; opinions, however unanimous, cannot invalidate truth, nor agitations, however powerful, distort justice ; justice is superior to appeasement ; truth is eternal *dharma*.

One would find it difficult to share the author's non-belief in what he calls the shifty findings of research, and his view that it is not necessary to determine the geographical position of Laṅkā as also to assign Rāma to any historical age. The historical basis of our national epics can never be challenged.

The author has presented very precious material within the short compass of 27 pages in an elegant style, and we commend the work to those interested in the epic and literary studies.

A. D. PUSALKER

Ancient Vijñaptipatras. By Jñānaratna Dr. Hirananda Sastri, M.A., M.O.L., D.Litt. Baroda, 1942. Pages ix+80 and 29 plates. Price Rs. 9-11-0.

THE present memoir represents the first publication in "Shree Pratapsinh Maharaja Rajyabhishek Granthamala" started to commemorate the accession of H. H. Maharaja Pratapsinh Gaekwad to the Gadi. Jñānaratna Dr. Hirananda Sastri took charge of the newly started Archaeological Department of the Baroda State after his retirement as Government Epigraphist, and in that capacity published some valuable memoirs besides the usual Annual Reports. He has now retired from the State service. The book under review is an amplified version of the original article contributed by Dr. Sastri to *Asia.*

The book is divided into four chapters and includes also an Appendix and 29 plates. The first chapter gives a few words about Jainism, its divisions, rituals and customs, etc., and in the next chapter are described the vijñaptipatras in general, their antiquity and importance, their script, size, material, language, etc. The third chapter contains methodology or general rules for writing and decorating letters, taken from the *Patrakaumudī* of Vararuci and other works. Detailed examination of 24 vijñaptipatras, some of which are illustrated in the plates at the end, forms the last chapter, followed by an Appendix containing some old Indian letters. There is an exhaustive Index at the end.

Vijñaptipatras are old scrolls or letters of solicitation written by one Jaina Saṁgha of a locality to the Ācārya (religious head) residing among another Jain Saṁgha inviting the Ācārya to stay with the inviters during the next *caümāsā.* Though mainly intended as invitations, these letters referred to various interesting topics and often gave historical information of considerable interest. The illustrations supply us with important social and cultural particulars hitherto unknown.

Vijñaptipatras were written on thick country paper, usually 10″ to 12″ in width, and sometimes running to 108 cubits in length (*Vijñaptitriveṇī*, p. 30). The script was Devanāgarī, though at times Marwadi and Gujarati were employed. They were written in Sanskrit, both in prose and verse or partly in Sanskrit and partly in some local dialect. Vijñaptipatras usually contained pictorial description of the locality from which the invitation issued.

The pictures gave realistic accounts of the social and religious customs, arts and crafts, professions, etc., of much importance for history, ethnology, sociology, art and architecture, etc.; the text is important for the study of the growth of dialects, for orthography, palaeography and comparative philology. These vijñaptipatras constitute a valuable source of information about the cultural life of all strata of society in Gujarat and Kathiawad not brought to light before, showing the great part Jainism played in preserving indigenous culture in the midst of disturbed political conditions. Dr. Sastri deserves congratulations for inviting attention to this important source of history, hitherto practically untapped.

Coming to the 24 vijñaptipatras contained in the present memoir, we find that they pertain to the late medieval period, so that the title "*Ancient* Vijñaptipatras" is not quite correct. . The earliest vijñaptipatra (No.1) is dated 1610 A.D., and the latest (No. 24), 1859 A.D. The largest (No. 14) measures 50.5′ by 10.5″, while the shortest (No. 3) is 8.8′ by 6.75″. There is ample evidence in these vijñaptipatras to show that sending vijñaptipatras was a Śvetāmbara custom. These documents also furnish important historical material hardly known before. The first vijñaptipatra in polychrome illustrations throws important sidelight on Jehangir's administration so far missed by historians. The Ghogha vijñaptipatra (No. 3) called *Prabodhadīpa* has 101 good Sanskrit verses written in various metres, and the Dewas scroll (No. 6) is a *Citrakāvya* consisting of *Padmabandha* and *Khaḍgabandha*. The pictures are realistic and accurate, and it appears that the later the artist, the more conventional he tends to become, the earlier specimens being more artistic. In most of the picture-scrolls illustrated, we come across musicians, male and female, with *vīṇā*, *pakhwaj*, *sarod* and cymbal, mother of a Jina sleeping with infant Jina on the lap, Śrīpūjya Ācārya with male and female disciples, 8 *maṅgalas* and 14 dreams. These pictures vividly show us the costumes, modes of living and social customs of the people in those days. Attention may be drawn in this connection to the farman of Jehangir forbidding the slaughter of animals during *paryuṣaṇa* (No. 1), the British flag and processionists wearing Maratha *pagḍi* (No. 2), Bhagwa *jhaṇḍā* with the moon figuring on it (No. 12), music before mosques (No. 13), woman shopkeeper (No. 17), etc. Unfortunately, the plates are not helpful for reading the text ; the reproductions are so minuscular as to render their decipherment with the naked eye most difficult, if not quite impossible. The text of the vijñaptipatras is no doubt important from philological, linguistic and palaeographical points, supplying valuable data for the study of the dialects in which they are written.

On p. 48 (l.20), "addressee" is a misprint for "addressor," and *12′* on p. 62 (l.2) should be *12″*. There will be some difference of opinion as regards the propriety or relevancy of devoting ten pages (32-42) to the explanation of technical terms. Dr. Sastri's interpretation of some pictures also will not commend itself to all.

We congratulate Dr. Sastri on this fine production, and hope that future investigations will bring to light many such scrolls which are lying unexamined in various Bhandaras and private collections, so that further light may be thrown on the history of our land.

A. D. PUSALKER

A History of the Canonical Literature of the Jainas. By Prof. H. R. Kapadia, M.A. Published by the author, Sankdi Sheri, Gopipura, Surat, 1941. Pages xii+272. Price Rs. 5-4-0.

THE need of a detailed and authoritative history of Jain Literature in English is keenly felt by all the serious students of Jainism. To some extent that is met by the account of Jain Literature in the second volume of Indian Literature by Winternitz. Prof. H. R. Kapadia, therefore, has compiled two volumes to give an exhaustive information about the Canonical and non-Canonical Literature of the Jains (see p.

207). In the volume under review an attempt is made to give, in seven Chapters, the history of the Canonical Literature of the Śvetāmbara Jains. The book begins with an Analysis of the various topics dealt with in it. Chapter 1 presents the Genesis of the Jain Scriptures, and their classification is described in the next. After dealing with the Redaction of the Jain Canon in the third chapter, the author takes up an inquiry into the possible causes that led to the loss of some Canonical books and explains in detail how the *Diṭṭhivāya* with its five sections (one of them being made up of the 14 *Puvvas*) came to be lost by stages in course of time. This chapter clearly shows what an amount of labour it must have entailed the author to piece together the valuable information lying scattered in various commentaries on the canonical books. But the fifth Chapter treating of the Extant Āgamas, does not give a connected account of the various Canonical books that are extant. Often the author contents himself with giving only the names of the different chapters of the Canonical books, or quoting the opinions of other scholars. The next Chapter is devoted to the account of the Exegetical literature on the Canonical books. Instead of giving information about the several *Cuṇṇis*, *Bhāsas*, etc., in one place, as the author has done, it would have been better had he given the account of the several exegetical works on each book of the Canon, under that particular book. The chapter, by the by, is not exhaustive in its treatment. All the available and known commentaries on the *Dasaveyāliyasutta*, for example, are not noted therein. The last chapter, "Comparison and Evaluation," is, it would seem, the weakest portion of the book. For, in his enthusiasm to point out the greatness of the Jain Canonical Literature, he finds references to all the things under the sun in these books, *e.g.*, "The first verse of *Dasaveyāliya* mentions the process of preparing gold" (p. 227) ! The queer procedure, adopted in the second Index, of arranging English and German words according to their pronunciation and at the same time following the order of Devanāgarī alphabet is rather unhappy.

The author deserves due credit for collecting much valuable information from the traditional sources, but the usefulness of the book is slightly reduced by lack of systematic presentation of the material. He has called his book "*A History*," but on perusal it is found that he has given only a traditional account of the Canonical Literature of the Jains, and in the few cases, where dates are given at all, they are given in the Vīra Saṁvat only and not according to the Christian Era. It is hoped that when the author publishes his second book on the non-Canonical Literature of the Jains, he will pay due regard to the systematic presentation and the historical method.

N. A. Gore

LIST OF THESES

Table showing the M. Ed. and Ph. D. Graduates in Arts with the titles of theses, etc., for the year 1942-43

Name of the Candidate	Title of Thesis	Guiding Teacher (Internal Referee)	Date of Result
	M. Ed.		
Chaubal, V. S.	The Place of Mother Tongue (Marathi) in Secondary Education with Special Reference to the Teaching of Composition	Miss S. Panandikar (S.T.C., Bombay)	October 1942
Chickermane, D. V.	Educational Measurements—Measurements of Arithmetical Ability in Kannada Primary Schools	Principal P. S. Katti (S.T.C., Belgaum)	October 1942
	Ph. D.		
	Marathi		
Watave, K. N.	Rasa-Vimarsha, Psychological Examination of the Rasa System with a view to lay down the Foundation of the Principles of Literary Criticism for Modern Marathi	Professor N. C. Kelkar (Sir P. College, Poona)	July 1942
	Persian		
Naik, C. R.	Abdur Rahim Khan-Khanan and his Literary Circle	Principal M. B. Rehman (I.C., Bombay)	November 1942

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Bharatiya Vidya Patrika
Bombay Law Journal
Bombay Teachers' Journal
D. J. Sind College Miscellany (Faculty of Arts)
Educational Review
Fergusson College Magazine
Gujarat College Magazine
Indian Information (English, Hindi and Urdu)
Indian P. E. N.
Journal of the Greater India Society
Lingaraj College Miscellany
Mahila Jyoti
Mansi
Mira
Nagri Pracharini Patrika
Nimbal Gazette
Parashuramian
Progress of Education
Publications of the Universidad de Santo Domingo
Pushpa—The Children's Own Paper
Ramnarain Ruia College Magazine
Religions
Ruzgar-i-Nau—Persian Quarterly Magazine
Shri Narsinha Priya
Sir L. A. Shah Law College Magazine
S. L. D. Arts College Magazine
St. Xavier's College Magazine
Sykes Law College Magazine
Teachers' College Journal, Baroda
Tilak College of Education Magazine, Poona
Upper Sind Collegian
Urmi
Viveka Magazine
Women's Sports World

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No. 3—A Glossary of Philosophical Terms (Samskrit-English), by C. V. Shankar Rau.

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ON ISOTROPIC SPACES

By

D. N. MOGHE

1. INTRODUCTION

IN differential geometry the condition for an isotropic space is given by the following relation, *viz.*,

$$B_{ijmn} = K\,(g_{im}\,g_{jn} - g_{in}\,g_{jm}) \qquad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

where K is the Riemannian curvature of the space V_n characterised by the line-element

$$ds^2 = g_{ij}\,dx^i\,dx^j \qquad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

Remembering Schur's theorem it is, therefore, evident from (1) that the expression of Riemann-Christoffel tensor is an easy task. On the contrary, if K is not constant (1) alternatively gives an expression for K in terms of B_{ijmn} and the g_{ij}'s at a particular point. It should be understood that formula (1) is the basis for any consideration of the isotropy of spaces. Clarification of some implications of this notion of isotropy is brought out here. With the usual meaning for the symbols we have

$$\left(\frac{dx^i}{ds}\right)_{,j}\frac{dx^j}{ds} = \frac{d^2x^i}{ds^2} + \left\{kj,\, i\right\}\frac{dx^k}{ds}\frac{dx^j}{ds} = P^i \qquad \ldots\ldots \quad (3)$$

It is easy to prove that

$$P^i_{,j}\frac{dx^j}{ds} - P^i_{,k}\frac{dx^k}{ds} = \frac{dx^j}{ds}\frac{dx^k}{ds}\frac{dx^k}{ds}\frac{dx^l}{ds}B^i_{\ ljk} \qquad \ldots\ldots\ldots\ldots \quad (4)$$

For an isotropic V_n we can, therefore, write

$$P^i_{,j} - K\,\delta^i_j = M^i_j \qquad \ldots\ldots\ldots\ldots \quad (5)$$

Let P_i be defined by the relation

$$P_i = g_{ij}\,P^j \qquad \ldots\ldots\ldots\ldots \quad (6)$$

The condition that P^i should define the geodesics is that

$$P_i\frac{dx^i}{ds} = 0 \qquad \ldots\ldots\ldots\ldots \quad (7)$$

i.e.,

$$P_i\,P^i + P_{i,j}\frac{dx^i}{ds}\frac{dx^j}{ds} = 0 \qquad \ldots\ldots\ldots\ldots \quad (8)$$

Also, $\quad P_{i,j} = g_{ik}\,P^k_{,j}$, and $M_{ij} = g_{ik}\,M^k_j \qquad \ldots\ldots\ldots \quad (9)$

$$M_{ij}\frac{dx^i}{ds}\frac{dx^j}{ds} = -(P+K) = -\,\Omega, \text{ say}, \qquad \ldots\ldots\ldots \quad (10)$$

where $\quad P = P_iP^i$. (10) can further simplify to

$$\gamma_{ij}\frac{dx^i}{ds}\frac{dx^j}{dx} = 0, \qquad \ldots\ldots\ldots \quad (11)$$

and $$\gamma_{ij}=M_{ij}+\Omega g_{ij}=P_{i,j}+P\,g_{ij} \qquad \ldots\ldots\ldots (12)$$

where, now V'n is another space given by

$$d\sigma^2=\gamma_{ij}\,dx^i\,dx^j \qquad \ldots\ldots\ldots\ldots (13)$$

whose null-geodesics are

$$P^i=0 \qquad \ldots\ldots\ldots\ldots (14)$$

In the following treatment similar reasoning is resorted to.

2. V_n Embedded in a V_m

(*a*) $m=n+1$. This is a special case a particular example of which was considered some time back by the present author.(1)
We have

$$ds^2=e a_{\alpha\beta}\,dy^\alpha\,dy^\beta=e\,g_{ij}\,dx^i\,dx^j \qquad \ldots\ldots (15)$$

As before, $$\left(\frac{dy^\alpha}{ds}\right)_{,j}\frac{dx^j}{ds}=y,^\alpha_{ij}\frac{dx^i dx^j}{ds\;ds}+y,^\alpha_i P^i \qquad \ldots\ldots (16)$$

where $$y,^\alpha_{ij}=e\gamma_{ij}\,\xi^\alpha-\{\epsilon\,\beta,\ \alpha\}\,y,^\epsilon_i\,y,P_j \ \ldots\ldots (17)$$

so that $$P^\alpha=e\gamma_{ij}\frac{dx^i\,dx^j}{ds\;ds}\,\xi^\alpha+y,^\alpha_i P^i \qquad \ldots\ldots (18)$$

It is pointed out that the Greek suffixes are for processes in V_m, etc., and that γ_{ij} is not the same as γ_{ij} of (1). Carrying out the same processes as in (1), and remembering equations of Gauss and Codazzi for a V_n immersed in a V_m, we get

$$M^\alpha=\left\{P,^\alpha_\mu\,y,^\mu_i-P,^k_i\,y,^\alpha_k+(K-K_0)\,y,^\alpha_i\right\}\frac{dx^i}{ds} \ \ldots (19)$$

where K_0 and K are the Riemannian curvatures of V_m and V_n respectively. It is easy to deduce the formula

$$a_{\alpha\beta}\,M^\alpha\frac{dy^\beta}{ds}=e\,(K-K_0)+(P-P_0) \qquad \ldots\ldots (20)$$

where P_0 for V_m has the same meaning as P for V_n. Full significance of M^α is brought out by (20).

(*b*) $m>n+1$. Here

$$P^\alpha=\sum_\sigma e_\sigma\gamma_{ij}\frac{dx^i\,dx^j}{ds\;ds}\,\xi^\alpha_{\sigma|}+y,^\alpha_i\,P^i \qquad \ldots\ldots (21)$$

The treatment is similar to that of (*a*) and results (19) and (20) can also be obtained for this case without much difficulty.

3. Spaces Conformal With Each Other

Let the conformal relation between V_n and V'_n be represented by

$$g'_{ij}=e^{2\tau}\,g_{ij} \qquad \ldots\ldots (22)$$

where $\tau=\tau\,(x)$ and $\tau_{,i}=\frac{\partial\tau}{\partial x^i}$. Suppose that a parametric representation of V_n is possible in the form of an equation of a surface, *viz.*;

$$s=f\,(\tau) \qquad \ldots\ldots (23)$$

so that, in the usual notation, we have

$$\left.\begin{aligned} \tau_{ij} &= \left\{ \frac{d^2\tau}{ds^2} - \left(\frac{d\tau}{ds}\right)^2 - P^{\alpha}\tau,_{\alpha} \right\} g_{ij}, \\ \text{and} \quad \triangle_1\tau &= n^2 g \left(\frac{d\tau}{ds}\right)^2, \; g = | g_{ij} | \cdot \end{aligned}\right\} \cdots\cdots \quad (24)$$

If V_n and V'_n are isotropic with curvatures K and K′ respectively, we have

$$e^{2\tau} K' = K - M \qquad \cdots\cdots \quad (25)$$

where $M = 2 \left\{ \frac{d^2\tau}{ds^2} + \frac{1}{2}(n^2 g - 1)\left(\frac{d\tau}{ds}\right)^2 - P^{\alpha}\tau,_{\alpha} \right\} \cdots \quad (26)$

If K is constant K′ is so only when

$$2e^{2\tau} K' \tau,_i + M,_i = o \qquad \cdots\cdots \quad (27)$$

It is very easy to prove that V_n and V' are either both isotropic or both non-isotropic.

Again, we have

$$\tau,_{ijm} - \tau,_{imj} = \left(g_{ij}\frac{\partial}{\partial x^m} - g_{im}\frac{\partial}{\partial x^j} \right)\left(\frac{d^2\tau}{ds^2} - P^{\alpha}\tau,_{\alpha} \right) \cdots (28)$$

Therefore, B^n_{ijm} can be expressed in a simple manner as :

$$\tau,_n B^n_{ijm} = \left(g_{ij}\frac{\partial}{\partial x^m} - g_{im}\frac{\partial}{\partial x^j} \right)\left(\frac{d^2\tau}{ds^2} - P^{\alpha}\tau,_{\alpha} \right) \qquad \cdots (29)$$

and also, $P'^{\alpha} = P^{\alpha} + \left(2\frac{dx^i}{ds}\frac{dx^{\alpha}}{ds} - g_i{}^{\alpha} \right)\tau,_i \qquad \cdots \qquad \cdots (30)$

The condition that V_n and V'_n shall have corresponding geodesics is :

$$\left(2\frac{dx^i}{ds}\frac{dx^{\alpha}}{ds} - g^{i\alpha} \right)\tau,_i = o \qquad \cdots \qquad \cdots (31)$$

This is virtually an indirect proof of Beltrami's theorem, namely, that the only spaces whose geodesics correspond to those of spaces of constant curvature are themselves spaces of constant curvature.

It will be seen that Weyl's conformal curvature tensor can simply be expressed as

$$C^n_{ijm} = \frac{M+K}{K} B^n_{ijm} \qquad \cdots \qquad \cdots \qquad \cdots \qquad \cdots (32)$$

Reference

(1) On Isotropic Manifolds in the Theory of Relativity. Proc. Ind. Acad. Sci., X, 4, pp. 275—278, October 1939.

INTERPOLATION AND SUMMATION FORMULAS AND THE PROPERTIES OF FACTORIALS—III

By

DR. D. K. SEN

§ 4. LUBBOCK'S FINITE SERIES INVOLVING F (x)

21. LUBBOCK has introduced three types of series of finite number of terms involving the factorial functions (*viz.*, P_{2p}, Q_{2p}, Λ_p). (*Cf.* Steffensen, *loc. cit.*, p. 139 *et. seq.*) I have derived, in this section, two new trigonometrical relations [*viz.* (94) and (105)] from which I have been able to deduce the recurrence formulæ for P_{2p} and Q_{2p}, some of which are new, *e.g.*, (100), (110), (112), (113), (113a). I have also obtained new asymptotic expressions [*viz.* (96) and (106)] for these when the integer p becomes infinitely large.

Let us take Stirling's interpolation formula once again, but for the following function :

$$f\left(n+\frac{x}{h}\right)=\sum_{p=o}^{r-1}\frac{1}{(2p)!}\left(\frac{x}{h}\right)^{[2p]}\delta^{2p}f(n)$$
$$+\sum_{p=1}^{r-1}\frac{1}{(2p-1)!}\left(\frac{x}{h}\right)^{[2p]-1}\square\,\delta^{2p-1}f(n)$$
$$+\left(\frac{x}{h}\right)^{[2r]-1}f(n+\frac{x}{h},\, n,\, n\pm1,\, \dots\, n\pm r\mp1) \tag{91}$$

where h is a positive integer. Now,

$$P_{2p}=\frac{1}{(2p)!}\sum_{x=-\frac{1}{2}(h-1)}^{\frac{1}{2}(h-1)}\left(\frac{x}{h}\right)^{[2p]}, \tag{92}$$

the summation being for the following values of x,

$-\frac{1}{2}(h-1),\ 1-\frac{1}{2}(h-1),\ 2-\frac{1}{2}(h-1),\ \dots\ \frac{1}{2}(h-1).$

Put $n=o$ in (91) and take the function $f(x)=\cos(2x\theta)$, so that $f\left(\frac{x}{h}\right)=\cos\frac{2x\theta}{h}$, and $\delta^{2p}f(o)=(-1)^p(2\sin\theta)^{2p}$ [See (59)].

Perform the summation on (91) for the values of x noted above. It can be easily seen that the second sum involving $\left(\frac{x}{h}\right)^{[2p]-1}$ does not con-

tribute anything to the result. Thus we get, on summing up the two sides of (91) for these values of x,

$$\frac{\sin\theta}{\sin\frac{\theta}{h}} = h + \sum_{p=1}^{r-1} (-1)^p P_{2p} (2\sin\theta)^{2p} + R(x), \tag{93}$$

separating the first term which gives Σ (1) or h.

If we replace x in (91) by $-x$, and repeat the process indicated above, we shall get (93) over again, the only change being $R(-x)$ in place of $R(x)$.

Taking the arithmetic mean of this and (93) we get

$$\frac{\sin\theta}{\sin\frac{\theta}{h}} = h + \sum_{p=1}^{r-1} (-1)^p P_{2p} (2\sin\theta)^{2p} + R,$$

where R, as Steffensen has proved it (*Cf. Interpolation*, p. 142), is equal to

$$P_{2r} f^{2r}(\xi), \text{ or, } P_{2r}(-1)^r (2\theta)^{2r} \cos 2\theta\xi.$$

It has been shown in p. 148 of that book that

$$| P_{2p} | \leqslant \frac{2P_2 (p!)^2}{p^2 (2p)!},$$

which for large values of p, approximates to

$$\frac{P_2 \pi^{1/2}}{2^{2p-1} p^{3/2}}.$$

Therefore,

$$| R | \leqslant \frac{2 P_2 \pi^{1/2} \theta^{2r}}{r^{3/2}}, \text{ and so } | R | \longrightarrow o \text{ when } r \longrightarrow \infty, \text{ if } | \theta | \leqslant 1.$$

Hence we obtain

$$\frac{\sin\theta}{\sin\frac{\theta}{h}} = h + \sum_{p=1}^{\infty} (-1)^p P_{2p} (2\sin\theta)^{2p}. \tag{94}$$

The right-hand series, however, is convergent for $| \sin\theta | \leqslant 1$, or $| \theta | \leqslant \frac{\pi}{2}$; therefore, the result (94) will be valid over this extended region. We will get interesting particular cases by putting $\theta = \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}$ and $\frac{\pi}{2}$.

Now, when $p \longrightarrow \infty$, P_{2p} will be the sum of terms of the type

$$\frac{1}{(2p)!} \frac{x^2}{h^2} \left(\frac{x^2}{h^2} - 1^2\right) \left(\frac{x^2}{h^2} - 2^2\right) \ldots\ldots,$$

or,

$$\frac{(-1)^{p-1} (p-1)! \, (p-1)!}{2p!} \cdot \frac{x}{h\pi} \sin\frac{x\pi}{h}.$$

Hence, by Stirling's theorem

$$P_{2p} \backsim \frac{(-1)^{p-1}}{2^{2p} \pi^{1/2} p^{3/2}} \sum_{x=-\frac{1}{2}(h-1)}^{\frac{1}{2}(h-1)} \frac{x}{h} \sin\frac{x\pi}{h}. \tag{95}$$

To evaluate the sum in (95) we observe that

$$\frac{h}{\pi}\frac{d}{dh}\left(\cos\frac{x\pi}{h}\right)=\frac{x}{h}\sin\frac{x\pi}{h};$$

and $$\sum_{x=-k}^{k}\cos\left(\frac{x\pi}{h}\right)=\frac{\sin\,(k+\frac{1}{2})\,\pi/h}{\sin\,\pi/2h}\text{ when } h=2m+1,$$

and $$=\frac{\sin k\,\pi/h}{\sin\pi/h},\text{ when } h=2m.$$

We get, however, in both cases that

$$\sum_{x=-(h-1)}^{\frac{1}{2}(h-1)}\left(\frac{x}{h}\sin\frac{x\pi}{h}\right)=\frac{1}{2h}\,\frac{\cos\pi/2h}{\sin^2(\pi/2h)}.$$

Therefore,

$$P_{2p}\backsim\frac{(-1)^{p-1}}{2^{2p+1}\,\pi^{1/2}\,p^{3/2}}\,\frac{\cos\pi/2h}{h\,\sin^2(\pi/2h)}. \qquad (96)$$

In order to find an upper limit of the last factor on the right-hand side of (96), we note that $\cos\frac{\pi}{2h}<1$, and $h\sin^2\frac{\pi}{2h}=\frac{1}{2}h\left(1-\cos\frac{\pi}{h}\right)$ $>\frac{\pi^2}{4h}\left(1-\frac{\pi^2}{12\,h^2}\right)>\frac{\pi^2}{4h}\left(1-\frac{1}{h^2}\right)$. Hence, for large values of p,

$$\left|P_{2p}\right|<\frac{1}{2^{2p-1}\,\pi^{5/2}p^{3/2}}\,\frac{h^3}{h^2-1}<\frac{\pi^{1/2}}{2^{2p-1}\,p^{3/2}}\,\frac{h^2-1}{24\,h},$$

the last value being the one obtained by Steffensen (l.c.) in a different way; this inequality is established here from the fact that h^2, being equal to or greater than 4, is greater than $\frac{\pi^{3/2}}{\pi^{3/2}-2\sqrt{6}}$, or 3.3 . ., and hence $\pi^3(h^2-1)^2>24h^4$.

Dividing (94) by h and then making $h\longrightarrow\infty$, we get

$$\frac{\sin\theta}{\theta}=1+\sum_{p=1}^{\infty}(-1)^p\ \underset{h\to\infty}{\text{Lt.}}\left(\frac{P_{2p}}{h}\right).(2\sin\theta)^{2p}.$$

On comparing this with (64) we get

$$\underset{h\to\infty}{\text{Lt.}}\left(\frac{P_{2p}}{h}\right)=K_{2p},$$

for all values of p, large or small. This result is also evident from the respective definitions of the two quantities.

Multiply both sides of (94) by $\sin\frac{\theta}{h}$, and utilise the following expansion of the factor

$$\sin\frac{\theta}{h}=\left(\frac{1}{2h}\right)^{[1]}.\,2\sin\theta-\left(\frac{1}{2h}\right)^{[3]}\frac{(2\sin\theta)^3}{3\,!}$$

$$+\left(\frac{1}{2h}\right)^{[5]}\frac{(2\sin\theta)^5}{5!}-\ \cdots\cdots \tag{97}$$

A comparison of the coefficients of $(-1)^p\,2^{2p}\sin^{2p+1}\theta$ from both sides will lead to the following recurrence formula :

$$0=P_{2p}+\frac{1}{3!}\left(\frac{1}{2h}\right)^{[3]-1}P_{2p-2}+\frac{1}{5!}\left(\frac{1}{2h}\right)^{[5]-1}P_{2p-4}+\ \cdots\cdots$$

$$+\frac{h}{(2p+1)!}\left(\frac{1}{2h}\right)^{[2p+1]-1}. \tag{98}$$

This recurrence formula was deduced by Steffensen by symbolic operational method (*Cf. Interpolation*, p. 193).

Multiply (98) by $\frac{1}{h}$ and make $h\longrightarrow\infty$. We shall then arrive at the result (66).

Differentiate (97) with respect to θ, and divide by $\frac{1}{h}\cos\theta$. Then

$$\frac{\cos\frac{\theta}{h}}{\cos\theta}=1-\left(\frac{1}{2h}\right)^{[3]-1}\frac{(2\sin\theta)^2}{2!}+\left(\frac{1}{2h}\right)^{[5]-1}\frac{(2\sin\theta)^4}{4!}-\ \cdots\cdots \tag{99}$$

Let us next replace θ in (94) by 2θ, multiply both sides by $\frac{\cos\frac{\theta}{h}}{\cos\theta}$ and then expand them in powers of $\sin\theta$. We then get the following :

$$-\left(1-\frac{1}{2^{2p}}\right)P_{2p}=\frac{1}{4^2}\left\{\frac{4}{2!}\left(\frac{1}{2h}\right)^{[3]-1}-p\right\}P_{2p-2}$$

$$+\frac{1}{4^4}\left\{\frac{4^2}{4!}\left(\frac{1}{2h}\right)^{[5]-1}+\frac{4p}{2!}\left(\frac{1}{2h}\right)^{[3]-1}+\frac{p(p-1)}{2!}\right\}P_{2p-4}.$$

$$+\cdots\cdots+\frac{h}{4^p\ (2p)!}\left(\frac{1}{2h}\right)^{[2p+1]-1}. \tag{100}$$

22. The second series of Lubbock is defined by

$$Q_{2p}=\frac{1}{(2p)!}\sum_{x=-\frac{1}{2}(h-2)}^{\frac{1}{2}(h-2)}\left(\frac{x}{h}\right)^{[2p+1]-1}, \tag{101}$$

where h is a positive integer, and the summation extends over values of x increasing by unity at every step.

Here, we take help of the Bessel's interpolation formula,

$$f\left(\frac{x}{h}+\frac{1}{2}\right)=\sum_{p=0}^{r-1}\frac{1}{(2p)!}\left(\frac{x}{h}\right)^{[2p+1]-1}\square\,\delta^{2p}f\left(\tfrac{1}{2}\right)$$

$$+\sum_{p=0}^{r-1}\frac{1}{(2p+1)!}\left(\frac{x}{h}\right)^{[2p+1]}\delta^{2p+1}f\left(\tfrac{1}{2}\right)+R,$$

and sum similar results corresponding to the above-mentioned values of x. Then

$$\sum_{x=-\frac{1}{2}(h-2)}^{\frac{1}{2}(h-2)} f\left(\frac{x}{h}+\tfrac{1}{2}\right)=\sum_{p=o}^{r-1} Q_{2p}\cdot\square\delta^{2p}f\left(\tfrac{1}{2}\right)+R' \qquad (102)$$

where R′ has been shown by Steffensen (*Cf. no. 1*, p. 146) to be given by

$$R'=Q_{2r}\,f^{2r}\,(\xi). \qquad (103)$$

Apply this formula to the function $f(x)=\cos(2x-1)\theta$. The sum of the series on the left-hand side can be easily found to be

$$\sin\theta\cot\frac{\theta}{h}-\cos\theta. \qquad (104)$$

Turning to the remainder-term, we observe that it has been proved in Steffensen, *loc. cit.*, p. 148, that

$$\left|Q_{2p}\right|\leqslant\frac{h^2-1}{12h}\cdot\frac{(2p)!}{(p!)^2}\cdot\frac{1}{2^{4p-3}},$$

which for large values of p approximates to

$$\frac{h^2-1}{3h}\,\frac{1}{2^{2p-1}\,p^{1/2}\pi^{1/2}}. \qquad (104a)$$

Hence,

$$|R'|\leqslant\frac{2(h^2-1)}{3h}\cdot\frac{\theta^{2r}}{r^{1/2}\pi^{1/2}}.$$

Therefore, $|R'|\to 0$ when $r\to\infty$, provided that $|\theta|\leqslant 1$. So, we have from (102), (104) and (44),

$$\frac{\tan\theta}{\tan\frac{\theta}{h}}=h+\sum_{p=1}^{\infty}(-1)^p\,Q_{2p}\,(2\sin\theta)^{2p}. \qquad (105)$$

This series is clearly convergent for $|\sin\theta|<1$, or $|\theta|<\frac{\pi}{2}$, and divergent for $|\theta|=\frac{\pi}{2}$. Hence the relation (105) holds so long as $|\theta|<\frac{\pi}{2}$. If we put $\theta=\frac{\pi}{6},\frac{\pi}{4}$ and $\frac{\pi}{3}$, we will get several particular cases of (105).

Each term of Q_{2p} tends to the following expression when $p\to\infty$.

$$\frac{(-1)^p}{2^{2p}\,\pi^{1/2}\,p^{1/2}}\left(1-\frac{4x^2}{h^2}\right)\left(1-\frac{4x^2}{3^2h^2}\right)\left(1-\frac{4x^2}{5^2h^2}\right)\,\cdots\cdots,$$

or, $$\frac{(-1)^p}{2^{2p}\,\pi^{1/2}\,p^{1/2}}\cos\frac{\pi x}{h}.$$

The sum $$\sum_{x=-\frac{1}{2}(h-2)}^{\frac{1}{2}(h-2)}\cos\frac{\pi x}{h}=\cot\frac{\pi}{2h}.$$

Therefore,

$$Q_{2p} \backsim \frac{(-1)^p}{2^{2p}\,\pi^{1/2}\,p^{1/2}} \cot \frac{\pi}{2h}. \tag{106}$$

An upper limit of $\cot \frac{\pi}{2h}$ is $\frac{4h^3}{\pi(2h^2-1)} < \frac{2(h^2-1)}{3h}$.

So, for large values of p,

$$\left| Q_{2p} \right| < \frac{1}{2^{2p}\,\pi^{\frac{1}{2}}\,p^{\frac{1}{2}}}\;\frac{4h^3}{\pi(2h^2-1)}$$

$$< \frac{1}{2^{2p}\,\pi^{\frac{1}{2}}\,p^{\frac{1}{2}}} \cdot \frac{2(h^2-1)}{3h}, \tag{107}$$

which is the same as (104a) quoted before but obtained here in a different manner.

Multiply both sides of (105) by $\sin \frac{\theta}{h}$, and expand them in powers of $\sin \theta$ with the help of (97) and (99). Equate co-efficients of $\sin^{2p+1}\theta$ from both sides, and we get after division by $(-1)^p . 2^{2p} . h^{-1}$,

$$\frac{2ph}{(2p+1)!}\left(\frac{1}{2h}\right)^{[2p+1]-1} = Q_{2p} + \frac{1}{3!}\left(\frac{1}{2h}\right)^{[3]-1} Q_{2p-2}$$

$$+ \frac{1}{5!}\left(\frac{1}{2h}\right)^{[5]-1} Q_{2p-4} + \ldots \text{ to p terms,} \tag{108}$$

It can be shown in the same way as in the case of P's, that

$$\underset{h \to \infty}{\text{Lt.}} \left(\frac{Q_{2p}}{h}\right) = M_{2p}, \tag{109}$$

It is also easy to see that (108) will reduce to (48) with the help of (109).

Transpose the first term on the right-hand side of (105), divide by $h \tan \theta$, and integrate both sides between the limits α and θ, where α is an arbitrary small angle. Then

$$\log \frac{\sin \frac{\theta}{h} \sin \alpha}{\sin\theta \, \sin \frac{\alpha}{h}} = \sum_{p=1}^{\infty} (-1)^p \, . \, 2^{2p}\, Q_{2p} \frac{\sin^{2p}\theta - \sin^{2p}\alpha}{2ph}.$$

Make $\alpha \to 0$ and we have

$$\log \frac{h \sin \frac{\theta}{h}}{\sin\theta} = \sum_{p=1}^{\infty} (-1)^p \; Q_{2p} \frac{(2 \sin\theta)^{2p}}{2ph}. \tag{110}$$

Differentiate both sides of (110) with respect to h, and we get after using the factor h;

$$1 - \frac{\theta \cot\theta}{h} \frac{\tan\theta}{\tan\frac{\theta}{h}} = \sum_{p=1}^{\infty} (-1)^p \; h \; \frac{d}{dh}\left(\frac{Q_{2p}}{2h}\right) \frac{(2 \sin\theta)^{2p}}{p}. \tag{111}$$

Since

$$\theta \cot \theta = 1 + \frac{\sin^2\theta}{3} + \frac{2}{3}\frac{\sin^4\theta}{5} + \frac{2.4}{3\cdot5}\frac{\sin^6\theta}{7} + \dots\dots\dots,$$

we get, by expanding the left-hand side of (111) in powers of $\sin\theta$ with the help of the above result and (105), and equating the coefficients of $(-1)^p \cdot (2\sin\theta)^{2p}$,

$$\frac{h}{p}\frac{d}{dh}\left(\frac{Q_{2p}}{2h}\right) = (-1)^{p+1}\frac{2.4.\ \dots\ (2p-2)}{3\cdot5\cdot\ \dots\ (2p-1)}\cdot\frac{1}{(2p+1)2^{2p}}$$

$$-\frac{1}{h}\Big[Q_{2p} - \frac{1}{3\cdot4}Q_{2p-2} + \frac{2}{3\cdot5}\frac{1}{4^2}Q_{2p-4}$$

$$-\frac{2.4}{3\cdot5}\frac{1}{7\cdot4^3}\quad Q_{2p-} + \ \dots \text{ to } p \text{ terms}\Big]. \qquad (112)$$

When $h \longrightarrow \infty$, the left-hand side tends to a limit whose value is given by replacing every $\frac{Q_{2p}}{h}$ by M_{2p}.

23. *Relations between* P's *and* Q's.

Since

$$\frac{\tan\theta}{\tan\frac{\theta}{h}} = \frac{\sin\theta}{\sin\frac{\theta}{h}}\ \frac{\cos\frac{\theta}{h}}{\cos\theta},$$

we get from (105) with the help of (94) and (99), after comparison of coefficients of $(-1)^p\ (2\sin\theta)^{2p}$,

$$Q_{2p} = \Big[P_{2p} + \frac{1}{2!}\left(\frac{1}{2h}\right)^{[3]-1} P_{2p-2} + \frac{1}{4!}\left(\frac{1}{2h}\right)^{[5]-1} P_{2p-4}$$

$$+ \dots \text{ to } p \text{ terms}\Big] + \frac{h}{(2p)!}\left(\frac{1}{2h}\right)^{[2p+1]-1} \qquad (113)$$

Multiply (98) by $(2p+1)$ and subtract (113) from the product. Then

$$-Q_{2p} = 2p\, P_{2p} + \frac{2\,(p-1)}{3!}\left(\frac{1}{2h}\right)^{[3]-1} P_{2p-2}$$

$$+ \frac{2}{5!}(p-2)\left(\frac{1}{2h}\right)^{[5]-1} P_{2p-4}$$

$$+ \dots \text{ to p terms}\ . \qquad (114)$$

If we divide (113) and (114) by h and make $h \longrightarrow \infty$, we shall get (75a) and (75) respectively.

§ 5. SUMMATION FORMULAS

24. We are here concerned only with the formulas of Lubbcck, Laplace and Gauss. These involve the use of Λ_p, P_{2p}, Q_{2p}, L_p, M_{2p}

and K_{2p} in the respective principal parts as well as in the remainder terms. It has been shown in this paper that

(1) the maximum ordinates of $F_n(x)$,

(2) the mean values of $F_n(x)$ in the intervals $(r, r+1)$, and

(3) the values of $F_n(x)$ at intervals of $x=1$, all decrease in magnitude as we proceed from either end of the interval $(0, n)$ towards the centre. And, the successive ratios increase with n. It is therefore not at all surprising that $|Q_{2p}| < |\Lambda_{2p}|$, and $|M_{2p}| < |L_{2p}|$; so, the formulæ involving Q_{2p} and M_{2p} will have a tendency to converge more rapidly, to have smaller error-terms than the ones containing Λ_p and L_p. From this point the former set of formulas is superior to the latter.

There is an additional advantage in our use of P_{2p} and K_{2p}.

We observe that we can put (*Cf.* Arts. 11 and 14)

$$M_{2p}=\frac{1}{(2p)!}\int_{p-1}^{p} F_{2p-1}(x)\,dx,$$

and

$$K_{2p}=\frac{1}{(2p)!}\int_{p-\frac{3}{2}}^{p-\frac{1}{2}} F_{2p-1}(x)\,dx=\frac{1}{(2p)!}\int_{p-\frac{1}{2}}^{p+\frac{1}{2}} F_{2p-1}(x)\,dx.$$

$F_{2p-1}(x)$ has the same sign in the interval $(p-1, p)$, but has different signs in the two halves of the interval of either of the integrals for K_{2p}, *e.g.*, $(p-\frac{1}{2}, p)$ and $(p, p+\frac{1}{2})$. And the intervals $(p-1, p)$ and $(p-\frac{1}{2}, p+\frac{1}{2})$ have a common half.

Likewise we can put,

$$Q_{2p}=\frac{1}{(2p)!}\sum_{x'=p-1+\frac{1}{h}}^{p-\frac{1}{h}} F_{2p-1}(x'),$$

there being $h-1$ terms in the sum obtained by increasing x' at every step by $\frac{1}{h}$.

$$\text{Next, } \left(\frac{x}{h}\right)^{[2p]}=(x'')^{[2p]}=x''F_{2p-2}(x''+p-1)$$

$$=F_{2p-1}(x''+p-1)+(p-1)F_{2p-2}(x''+p-1)$$

$$=F_{2p-1}(x')+p-1)F_{2p-2}(x'), \tag{115}$$

where $x'=x''+p-1$.

Summing for these h terms, we get

$$P_{2p}=\frac{1}{(2p)!}\sum_{x'=p-\frac{3}{2}+\frac{1}{2h}}^{p-\frac{1}{2}-\frac{1}{2h}} F_{2p-1}(x').$$

The ranges of the variable set forth in the above equivalent expressions of these quantities are such that the terms of the finite series in P_{2p} or the terms of the infinite series (or the definite integral) in K_{2p} are positive for half the range and negative for the other half. Whereas the terms of Q_{2p} and M_{2p} are of the same sign throughout the range. The ranges also do not differ much from one another. Hence, it is obvious that P_{2p} will be much smaller than Q_{2p}, and K_{2p} than M_{2p}. It follows from (114) and (75) that P_{2p} and K_{2p} are less than $\frac{1}{2}\,p$-th of Q_{2p} and M_{2p} respectively. A comparison of the actual values of these quantities for the first few values of p, and of their asymptotic values will show their comparative magnitudes.

25. Any interpolation formula involving the central factorial $x^{[2p]}$, or $x^{[2p]-1}$ may be used to obtain the principal terms of the first Gaussian summation-formula, or the second formula of Lubbock ; in the same way any interpolation-formula in $x^{[2p+1]}$ or $x^{[2p+1]-1}$ will lead to the principal terms of the second Gaussian formula or the third formula of Lubbock. Stirling's or Bessel's interpolation formula has, however, an advantage that the remainder can be expressed directly in terms of K_{2p} or M_{2p}, so that a smaller *upper limit* of the remainder-term can be obtained in this case than in others. But, after all, we are able to find an estimate of an upper limit of the residue ; and the magnitudes of upper limits calculated from the other formulas will not differ much from each other. This will be illustrated in the next article.

26. Let us deduce the first Gaussian summation formula from the first Gaussian interpolation formula (*Cf.* Steffensen, *loc. cit.*, p. 26), *viz.*,

$$f(x)=\sum_{n=0}^{p}\left[\frac{x^{[2n]-1}}{(2n-1)!}\,\Delta^{2n-1}f(-n)\right.$$
$$\left.+\frac{(x+n)\,x^{[2n]-1}}{(2n)!}\,\Delta^{2n}f(-n)\right]+R, \tag{116}$$

$$\text{where } R=\frac{x^{[2p+2]-1}}{(2p+1)!}\,f^{2p+1}(\xi). \tag{117}$$

Now,

$$\int_{-1/2}^{m-\frac{1}{2}} f(x)\,dx=\sum_{n'=0}^{m-1}\int_{-1/2}^{+1/2} f(n'+x)\,dx$$
$$=\sum_{n'=0}^{m-1}\left\{\sum_{n=1}^{p}\int_{-1/2}^{+1/2}\frac{x^{[2n]-1}}{(2n-1)!}\,\Delta^{2n-1}f(n'-n)\,dx\right.$$
$$\left.+\int_{-1/2}^{+1/2}\frac{(x+n)\,x^{[2n]-1}}{(2n)!}\,\Delta^{2n}f(n'-n)\,dx+R\right\}$$
$$=\sum_{n'=0}^{m-1}f(n')++\sum_{n'=0}^{m-1}\left\{\sum_{n=1}^{p}K_{2n}\Delta^{2n}f(n'-n)\right\}$$
$$+R', \tag{118}$$

$$\text{where } R' = \sum_{n'=0}^{m-1} \left\{ \int_{-1/2}^{+1/2} \frac{x[2p+2]-1}{(2p+1)!} f^{2p+1}(\xi)\, dx \right.$$

$$= \sum_{n'=0}^{m-1} \left\{ \int_{-1/2}^{0} + \int_{0}^{+1/2} \frac{x[2p+2]-1}{(2p+1)!} f^{2p+1}(\xi)\, dx. \right. \qquad (119)$$

Now $f^{2p+1}(\xi)$ is really a function of x, and we can put it as $F(x)$. Applying the Theorem of Mean Value to the two integrals of (119), we obtain

$$R' = \sum_{n'=0}^{m-1} \sigma_{2p} \left\{ F(x_2) - F(x_1) \right\}$$

$$= \sum_{n'=0}^{m-1} \sigma_{2p} (x_2 - x_1) F'(x_3),$$

where x_1 is some value between $-\frac{1}{2}$ and o, x_2 another value between o and $\frac{1}{2}$, and x_3 a third between x_1 and x_2, and thus $-\frac{1}{2} < x_3 < \frac{1}{2}$. We have

$$\frac{f^{2p+1}(\xi)}{(2p+1)!}, \text{ or } \frac{F(x)}{(2p+1)!} = f(x, 0, \pm 1, \pm 2, \ldots, \pm p).$$

Therefore,

$$\frac{f(x+\triangle x, x, 0, \pm 1, \pm 2, \ldots, \pm p) - f(x, 0, \pm 1, \pm 2, \ldots, \pm p)}{x+\triangle x - x}$$

$$= f(x+\triangle x, x, 0, \pm 1, \pm 2, \ldots, \pm p).$$

$$\text{Hence, } \frac{F'(x)}{(2p+1)!} = f(x, x, 0, \pm 1, \ldots, \pm p) = \frac{f^{2p+2}(\xi)}{(2p+2)!}.$$

We have further, $| x_2 - x_1 | < 1$, and so,

$$| R' | < m. \left| \frac{\sigma_{2p}}{2p+2} f^{2p+2}(\xi) \right|, \qquad (120)$$

this ξ being different from the previous one but lying between the same limits.

The result (118) is the same as the first formula of Gauss except for the value of the remainder-term obtained here. The sign of R' is that of $\frac{\sigma_{2p}}{2p+2} f^{2p+2}(\xi)$, since $(x_2 - x_1)$ is positive.

[*To be concluded*]

RAJARAM COLLEGE,
KOLHAPUR

FORMULATION OF THE PRODUCT OF DEMLO-NUMBERS

By

PROFESSOR M. L. CHANDRATRAYA, M.A.,

AND

D. R. KAPREKAR, B.SC., S.T.C.

(1) THE article on the general approach to the Theory of product of two demlo-numbers has found place in the B. U. J., March 1943. It is explained there that the product of two demlo-numbers $M\ (r)_n\ P \times M'\ (r')_{n'}\ P'$ can be written as

$$\frac{G}{81}\left(10^{n+n'} - 10^{n} - 10^{n'} + 1\right)$$

$$= \left(Q + \frac{R}{8}\right)\left(10^{l} - 10^{m} - 10^{j} + 1\right)$$ where we shall suppose that j is the smaller of the two n and n' and m is the bigger. We shall call m the higher element and j the lower. Then a process is recommended with three theorems in this connection. Various features of the process may be recalled by repeating a particular example.

(2) Thus take $15\ (4)_8\ 29 \times 19\ (5)_6\ 36$

$$= 139 \times 176 \times (1)_{10} \times (1)_7$$

$$= 24464\ (10^{10} - 1)\ (10^{7} - 1)/81$$

$$= 302\ \frac{2}{81}\ (10^{17} - 10^{10} - 10^{7} + 1)$$

The recurring period of $\frac{2}{81}$ = $.\dot{0}2469135\dot{8}$ called R. Thus in the product, the different results of multiplication are thus written out

302.0246913580246913580246913 I

302024691358 0.246913 II

3020246913.58024 III

302.02469 IV

Here II and III are to be subtracted from I and IV is to be added at the end.

II subtracted from I gives by theorem I (given in the last article, B. U. J., March 1943).

302024661155555555555.555 V

III subtracted from this value V gives

302024661125353308641.9753086 VI

giving the recurrence of the underlined digits as a period coming again and again. This is period of $\frac{43}{81}$ expressed as a recurring decimal. We shall call 43 as R′.

Lastly IV is to be added to this value of VI giving

302024661125353308943·999999 . . . . .

The decimal replaced by 1 gives the required product as

302024661125353308944.

(3) It can be seen that after the integer figures the period R stands on the left while that of R′ stands on the right. Of course the actual values of these are changed by the subtraction or addition of the integer value Q in different places. Even at stage VI the period of $\frac{R}{81}$ is to be subtracted from the repeated digit r (5 in the example taken). We can write this as $(r)_K - \frac{R}{81}$ and this gives the period of $\frac{R'}{81}$. Now r can have any values from 1 to 9 and R can have any value from 1 to 81. A table has been constructed to find the value of R′ corresponding to every value of r and R. As soon as R′ is known its period may be found from the table of $\frac{M}{81}$.

(4) We also distinguish the type of the product whether it is (+,+), (0,0), (+, +), (+,0). The integers in line II or III will be increased by unity or not according to the type of the case under consideration. For the type (+,+) integers in both the subtractions at stages V and VI will be increased by one, with corresponding interpretations for other tpyes. A table of types depending on the lower element and the value of R is also prepared.

(5) The following quantities have to be determined in the expression of the product.

G = the product of demlofiers

Q = the integral part of G/81

R = the remainder in G/81

j = the lower element

m = the higher element

d = the difference of the elements, *i.e.*, $m-j$

r = the repeating digit in V and which is the digital root of Rxj

R′ = the number that corresponds to R and found from the value of R and r

R and j determine the type of the product.

It is assumed that the lower element has the value from 1 to 9. In any case, if it is greater than 9, then we go on subtracting 9 from it in succession and the remainder considered as the lower element. This is quite justified for a greater value than 9 simply means that the period is completely taken and more digits in excess.

(6) We now state theorem IV without Proof. The proof will find its place elsewhere.

Theorem IV—The digital root of the product of R and j gives the repeated digit r occurring in the difference of I and II. (Thus in the example taken $R=2$, $j=7$ $\therefore$ $2\times7=14$ which gives the digital root 5; and this is the digit repeated in V.)

We would also define a term R_j. If only j digits of the period from $\frac{R}{81}$ are taken beginning from left to right the number will be written as R_j. Thus $R=2, j=7$ as above, $R_j=2046913$ for $\frac{R}{81}=.\dot{0}2469135\dot{8}$. If $j=9$, complete period of $\frac{R}{81}$ should be taken. If the period of $\frac{R}{81}$ contains only three digits or one digit then repetition should be made until we reach the number of j digits. A similar notation may be used for R'_j.

(7) The actual process of writing down the product of two demlo-numbers can now be described. First write

$$Q R_j \, (r)_{m-j} \quad R'$$

In this, $(r)_{m-j}$ is the single digit r repeated m_{-j} times. The last digits of R_j, $(r)_{m-j}$ and R'_j should be marked by dots above these digits. Then find the type of the product either (o, o), (+, +), (+, o), (o, +).

Suppose the product to be (o,o) type. Then write Q with the unit digits of Q, below all the three marked digits. Subtract the first two values of Q so written and add the last from left and then add 1 at the end to make up for the .9999 . . . in the decimals, giving the required value.

Thus if $Q=lmn=Qabcde\ldots\dot{f}\ rrrrrr\ldots\dot{r}\ \alpha\ \beta\gamma\delta\epsilon\ldots\dot{k}$

and $\qquad lmn \ (-) \qquad lmn\ (-) \qquad lmn\ (+) \quad +1$

will indicate the process. If the product is of (+, o) type, instead of writing Q, Q, Q with unit places under the marked digits, write $Q+1$, Q, and Q and then the process of subtractions and additions may be gone through. (+, +) type would indicate $Q+1$, $Q+1$, Q to be the quantities to be taken for this case. We shall illustrate the method by taking two or three examples.

(8) $25\ (8)_4 63\times 21\ (2)_9 01=549\frac{34}{81}(10^{17}-10^{11}-10^{6}+1)$

Here $Q=549$, $R=34$, $j=6$, $m-j=5$

r=digital root of $34\times6=6$.

$R=34$ and $r=6$ we find $R'=20$.

$\frac{R}{81}=419753086$ $\frac{R'}{81}=246913580$

$Rj=419753.\quad R' =246913.\quad$ Type $(+, 0)$

$$\begin{array}{rrrr} \therefore\ 549 & 419753 & 66666 & 246913 \\ & 550 & 549 & 549 \\ & - & - & +, \\ & & & +1 \\ \hline 549 & 419203 & 66117 & 247463 \end{array}$$

This is the product.

The quantity added last may be taken to be always $Q+1$ and the product thus written out. Thus the whole process may be symbolically represented by

$$\begin{array}{ccc} Q\ R_j & (r)_{m-j} & R'_j \\ (Q) & (Q) & Q+1 \end{array}$$

When the encirclement of Q shows that we have to take either Q or $Q+1$ depending on the type of the product.

(9) Take $25\ (8)_2\ 63\times 18\ (4)_5\ 26$

Here $Q=477$, $R=41$, $j=4$, $m-j=3$ digital value of $41\times4=2$, $R'=58$ $Rj=5061$, $R'j=7160$ and the type is $(0, +)$

$\therefore$ The product is given by

$$\begin{array}{rrrr} 477 & 5061 & 222 & 7160 \\ & 477 & 478 & 478 \\ & - & - & + \\ \hline i.e.,\ 477 & 4583 & 744 & 7638 \end{array}$$

(10) Sometimes overlapping takes place. If we take proper account of this overlapping, the process may be exactly followed and the result obtains the required product. Thus

$$25\ (8)_1 63\times 18\ ((4)_1 26$$

gives $Q=477$, $j=3$, $R=41$, $m-j=0$ $R'=13$ $r=$digital root 6. $Rj=506$ $Rj'=160$ and the type $(+, 0)$.

$$\begin{array}{lrrr} \text{Hence} & 477 & 506 & 160 \\ & & -478 & 478 \\ & & -477 & \\ \hline \text{giving} & 476 & 551 & 638 \end{array}$$

as the product.

(11) The product of superwonderful demlo-numbers described in B. U. J., March 1942, becomes merely a particular case.

Thus $W\frac{9}{5}\times 895$ *i.e.*, $895\times(1234567899999987654321)$

$$=895\times\frac{(10^9-1)\ (10^{13}-1)}{81}=11\frac{4}{81}\left\{10^{22}-10^{13}-10^9+1\right\}$$

Here $\qquad Q=11$, $R=4$, $j=9$, $m-j=4$, $R'=77$

$Rj = 049382716 \qquad R'j = 950617283$

and the type is $(+, 0)$. Digital root is 9.

Hence the process gives

```
    |       |       |
110493827 16 9999 950617283
         12   11         12
---------------------------------
110493827 04 9988 950617295
```

as the value of the product.

In short the product of any two demlo-numbers can in this way be put down at once only if we have some tables of results ready. The tabulated results necessary for this purpose are only of four varities.

(1) Table of $\frac{M}{81}$, (2) Table of types, (3) Table of R′, (4) Table of *r*.

The observation of these tables is also very interesting. A detailed description of the construction of such tables and their properties will form the subject matter of the next article.

College of Engineering, Poona
Khare's Wada, Deolali

LECTURE NOTES

(1) Some Uses of the Second M. V. T. for Integrals

By

Professor G. K. Hebalkar M.Sc.

In this article I propose to point out a few uses of the Second Mean Value Theorem for integrals. As far as I know these uses are not given in any book on Analysis or Calculus.

(i) *Abel's test for the uniform convergence of an integral :—*

Suppose $\int_a^{\infty} \phi(x)\, dx$ converges, and $f(x, y)$ is bounded and is monotonic for every fixed value of y in (y_0, y_1) ; then $\int_a^{\infty} f(x, y)\ \phi(x)\ dx$ converges uniformly in $y_0 \leqslant y \leqslant y_1$,

Proof :—Since $\int_a^{\infty} \phi(x)\,dx$ converges, we can find a number X such that

$$\left| \int_X^{X'} \phi(x)\,dx \right| < \epsilon \quad \text{for all } X' > X$$

Now by the second M. V. T. for integrals:

$$\int_X^{X'} f(x,y)\,\phi(x)\,dx = f(X,y)\int_X^{\xi} \phi(x)\,dx + f(X',y)\int_{\xi}^{X'} \phi(x)\,dx \qquad X \leqslant \xi \leqslant X'$$

$$\therefore \left| \int_X^{X'} f(x,y)\,\phi(x)\,dx \right| \leqslant |f(X,y)| \left| \int_X^{\xi} \phi(x)\,dx \right| + \left| f(X',y) \right|$$

$$\left| \int_{\xi}^{X'} \phi(x)\,dx \right| \leqslant 2k\,\epsilon \quad \text{if } |f(x,y)| \leqslant k \text{ for all } x, y.$$

The number X is independent of y and hence $\int_a^{\infty} f(x,y)\,\phi(x)\,dx$ converges uniformly for $y_0 \leqslant y \leqslant y$,

(ii) *Dirichlet's test for the uniform convergence of an integral* :—

Let $\int_a^{\infty} \phi(x)\,dx$ oscillate between finite limits and let $f(x, y)$ be monotonic and steadily decrease to zero, as x increases, uniformly for all values of y in $y_0 \leqslant y \leqslant y_1$, then $\int_a^{\infty} f(x,y)\,\phi(x)\,dx$ converges uniformly in $y_0 \leqslant y \leqslant y_1$

Proof :—Choose X such that $|f(x,y)| < \epsilon$ for all $x > X$ and for all values of y in $y_0 \leqslant y \leqslant y_1$. This is possible in virtue of the data.

Now by the second M. V. T. for integrals (as in the above case) :

$$\left| \int_X^{X'} f(x,y)\,\phi(x)\,dx \right| \leqslant |f(X,y)| \left| \int_X^{\xi} \phi(x)\,dx \right| + \left| f(X',y) \right|$$

$$\left| \int_{\xi}^{X'} \phi(x)\,dx \right| \leqslant 2k\,\epsilon$$

provided $\left| \int_{t_0}^{t} \phi(x)\, dx \right| \leqslant k$ for all t, t_0.

This last condition is satisfied since $\int \phi(x) dx$ is given to be oscillatory within finite limits. Again the number X is independent of y,

$\therefore \int_a^\infty f(x, y)\, \phi(x)\, dx$ converges uniformly in $y_0 \leqslant y \leqslant y_1$.

(iii) Abel's test for ordinary convergence of improper integrals of the second kind:—

An infinite integral which converges (although not absolutely) will remain convergent after the insertion of a factor which is monotonic and less than a fixed number in numerical value.

Suppose $\phi(x)$ is monotonic and bounded, $f(x)$ has $x=b$ as a point of singularity, and $\int_a^b f(x)\, dx$ is convergent. We can find a number δ_1, such that

$$\left| \int_{b-\delta_1}^{b-\delta} f(x)\, dx \right| < \epsilon \quad \text{for all +ve } \delta < \delta_1 \qquad \ldots\ldots \quad \text{I}$$

If now $o < \delta \leqslant \delta_1$, by Second M. V. T. for Integrals:

$$\int_{b-\delta_1}^{b-\delta} \phi(x) f(x)\, dx = \phi(b-\delta_1) \int_{b-\delta_1}^{\xi} f(x)\, dx + \phi(b-\delta) \int_{\xi}^{b-\delta} f(x)\, dx$$

$$b-\delta_1 \leqslant \xi \leqslant b-\delta$$

$$\left| \int_{b-\delta_1}^{b-\delta} \phi(x) f(x)\, dx \right| \leqslant \left| \phi(b-\delta_1) \int_{b-\delta_1}^{\xi} f(x)\, dx \right|$$

$$+ \left| \phi(b-\delta) \int_{\xi}^{b-\delta} f(x)\, dx \right|$$

$\leqslant 2\,\mathrm{K}\,\epsilon$ by (I) if $|\phi(x)| < k$ for all x in (a, b)

$\therefore$ by the general test, $\int^b \phi(x) f(x)\, dx$ is convergent.

(iv) *Dirichlet's test for ordinary convergence of improper integrals of the second kind* :—

An infinite integral which oscillates finitely becomes convergent after the insertion of a monotonic factor which tends to zero as a limit.

Proof :—Let $\phi(x)$ be monotonic and tend to zero as $x \longrightarrow b$, and let

$\int_a^t f(x)\,dx$ oscillate finitely as $t \longrightarrow b-o$.

Now since $\phi(x) \longrightarrow o$ as $x \longrightarrow b-o$ we can select a number δ_1 such that $|\phi(x)| < \epsilon$ for all x such that $b-\delta_1 \leqslant x < b$ I
By Second M. V. T.

$$\int_{b-\delta_1}^{t} \phi(x) f(x)\,dx = \phi(b-\delta_1)\int_{b-\delta_1}^{\xi} f(x)\,dx + \phi(t)\int_{\xi}^{t} f(x)\,dx$$

$$b-\delta_1 \leqslant \xi \leqslant t < b$$

$$\left|\int_{b-\delta_1}^{t} \phi(x) f(x)\,dx\right| \leqslant \left|\phi(b-\delta_1)\int_{b-\delta_1}^{\xi} f(x)\,dx\right| + \left|\phi(t)\int_{\xi}^{t} f(x)\,dx\right|$$

$$\leqslant 2K\epsilon \quad \text{by I,}$$

where K is greater than the absolute value of $\int^{t} f(x)\,dx$ as t varies in

$a \leqslant t < b$

Hence $\int_a^b \phi(x) f(x)\,dx$ converges.

NOWROSJEE WADIA COLLEGE,
POONA

(2) To Distinguish the Two Bisector Planes of the Angles Between Two Given Planes

By

HASMUKH P. OZA, M.SC.

IN *Journal of the University of Bombay*, Vol. X, Part 5, March 1942, has appeared an article by Mr. K. N. Wani, M.Sc., on "Bisector planes of the angles between two given planes," which distinguishes, and so far as I know for the first time, between planes bisecting acute and obtuse angles. I offer the following more lucid alternative method.

Let the two planes be

$$\left.\begin{array}{l} a_1 x+b_1 y+c_1 z+d_1=o \\ a_2 x+b_2 y+c_2 z+d_2=o \end{array}\right\}, \quad . \quad . \quad . \quad \text{(A)}$$

d_1 and d_2 having the same sign.

The bisector plane of the angle containing the origin is

$$\frac{a_1 x+b_1 y+c_1 z+d_1}{\left|\sqrt{a_1^2+b_1^2+c_1^2}\right|}-\frac{a_2 x+b_2 y+c_2 z+d_2}{\left|\sqrt{a_2^2+b_2^2+c_2^2}\right|}=o \quad . \quad . \quad . \quad \text{(B)}$$

and the other is

$$\frac{a_1 x+b_1 y+c_1 z+d_1}{\left|\sqrt{a_1^2+b_1^2+c_1^2}\right|}+\frac{a_2 x+b_2 y+c_2 z+d_2}{\left|\sqrt{a_2^2+b_2^2+c_2^2}\right|}=o \quad . \quad . \quad . \quad \text{(C)}$$

The *d. c.'s* of the perpendiculars from the origin to the two planes (A) are proportional to (a_1, b_1, c_1) and (a_2, b_2, c_2). And if θ is the angle, containing the origin, between the planes (A), then the angle between the perpendiculars from the origin is $(\pi-\theta)$, giving

$$\text{Cos }(\pi-\theta)= -\text{Cos }\theta=\frac{a_1 a_2+b_1 b_2+c_1 c_2}{\left|\sqrt{a_1^2+b_1^2+c_1^2}\sqrt{a_2^2+b_2^2+c_2^2}\right|} \quad . \quad . \quad \text{(D)}$$

Now Cos θ is $+ve$ or $-ve$ according as θ is acute or obtuse. And as the denominator of the right hand side of (D) is positive, we have θ acute or obtuse according as $a_1 a_2+b_1 b_2+c_1 c_2$ is $-ve$ or $+ve$.

Thus (B), the bisector plane of the angle containing the origin, bisects the acute or the obtuse angle according as $a_1 a_2+b_1 b_2+c_1 c_2$ is $-ve$ or $+ve$. When the status of (B) is known that of (C) follows immediately.

When one or both of the planes (A) pass through origin, *i.e.*, d_1 or d_2 or both of them are zero, we may push the plane or planes passing through the origin slightly along their respective normals, apply the foregoing analysis and then proceeding to the limit get the same condition as before.

DHARMENDRASINHJI COLLEGE,
RAJKOT

RELATIVISTIC DISTRIBUTIONS OF MATTER OF RADIAL SYMMETRY

By

G. K. PATWARDHAN AND P. C. VAIDYA

(*Communicated by Professor V. V. Narlikar, Benares Hindu University*)

1. INTRODUCTION

TOLMAN[1] has recently considered static solutions of Einstein's field equations for spheres of fluid. Following a new approach he has been able to give some new solutions. Alternative methods of attack are devised in this paper leading to Tolman's solutions and several others. The question of boundary conditions which is usually slurred over in discussions of this problem is examined and a new relation is brought to light which explains the inner consistency of all known solutions in spite of the inadequate treatment of the conditions at the surface of a fluid.

It is customary to take for static distributions of spherical symmetry the line-element[2],

$$ds^2 = -e^{\lambda} dr^2 - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2) + e^{\nu} dt^2, \tag{1}$$

$$\lambda = \lambda(r), \quad \nu = \nu(r)$$

as it involves no loss of generality. The non-zero components of the energy-momentum tensor are

$$8\pi T_1^1 = -8\pi p = -e^{-\lambda}\left(\frac{\nu'}{r} + \frac{1}{r^2}\right) + \frac{1}{r^2} - \Lambda, \tag{2}$$

$$8\pi T_2^2 = 8\pi T_3^3 = -8\pi q = -e^{-\lambda}\left(\frac{\nu''}{2} - \frac{\lambda'\nu'}{4} + \frac{\nu'^2}{4} + \frac{\nu' - \lambda'}{2r}\right) - \Lambda, \tag{3}$$

$$8\pi T_4^4 = 8\pi \rho = e^{-\lambda}\left(\frac{\lambda'}{r} - \frac{1}{r^2}\right) + \frac{1}{r^2} - \Lambda. \tag{4}$$

Here and in what follows a dash denotes a differentiation with regard to r as in λ'. The cosmological constant Λ can be safely neglected in discussions of fluid spheres of stellar dimensions. The only non-trivial condition given by $\left(T_{\mu}^{\nu}\right)_{\nu} = 0$ is

$$p' + (\rho + p)\,\nu'/2 + 2\,(p - q)/r = 0 \tag{5}$$

The equation (5), it will be remembered, is implicit in (2), (3) and (4). From (4) it follows that

$$e^{-\lambda} = 1 - \frac{2m}{r} + \frac{A}{r} \tag{6}$$

where

$$m = \int_0^r 4\,\pi\, r^2\, \rho\, dr \tag{7}$$

and A is the constant of integration. Since the field inside a sphere must reduce to flat space-time when $\rho = 0$, the constant A is taken as zero. Moreover, the boundary condition that $g_{\mu\nu}$ must be continuous, demands that we put

$$e^{-\lambda} = 1 - \frac{2m}{r}\ . \tag{6.1}$$

The condition of isotropy for pressure, *viz.*, $p = q$, simplifies (5):

$$p' = -(p+\rho)\, \nu'/2; \tag{5.1}$$

and (2) and (3) provide the differential equation,

$$e^{-\lambda}\left(\tfrac{1}{2}\nu'' + \tfrac{1}{4}\nu'^2 + \frac{\nu' - \lambda'}{2r} - \frac{\lambda'\nu'}{4}\right) = e^{-\lambda}\left(\frac{\nu'}{r} + \frac{1}{r^2}\right) - \frac{1}{r^2}\ . \tag{8}$$

Tolman writes this in the form,

$$\frac{d}{dr}\left(\frac{e^{-\lambda} - 1}{r^2}\right) + \frac{d}{dr}\left(\frac{e^{-\lambda}\nu'}{2r}\right) + e^{-\lambda-\nu}\frac{d}{dr}\left(\frac{e^{\nu}\nu'}{2r}\right) = 0\ . \tag{8.1}$$

The form suggests the various assumptions,

$$\text{(i) } e^{\nu}\nu'/2r = \text{const.},\quad \text{(ii) } e^{\nu} = \text{const.}\ r^{2n},\quad \text{(iii) } e^{-\lambda} = \text{const., etc.} \tag{9}$$

Corresponding to them Tolman has obtained the various new solutions. It is obvious that when λ and ν are known the field is completely determined. As the problem of an isotropic spherical distribution ultimately hangs upon the isotropy equation (8) we will proceed now to consider it at some length.

2. The Isotropy Equation

Considered as a first order differential equation in $e^{-\lambda}$ (8) presents the solution,

$$e^{-\lambda} = \frac{r^2}{F^2}\, e^{-\int_0^r G dr}\left[A - \int_0^r \frac{2}{r^3}\, F\, e^{\int_0^r G dr}\, dr\right] \tag{10}$$

where $$F = 1 + \frac{r\nu'}{2}, \tag{11}$$

$$G = \frac{r\nu'^2}{1 + r\nu'/2} - \nu' \tag{12}$$

and A is an arbitrary constant. For models which are not cosmological λ and ν must tend to zero simultaneously. Hence A=o. If we put

$$e^{\nu/2} = e^{\int \frac{dr}{\chi}}, \tag{13}$$

we get $$F = \frac{\chi + r}{\chi}, \tag{11.1}$$

$$G = \frac{2(r-\chi)}{\chi(\chi+r)}. \tag{12.1}$$

(10) and (13) formally provide the solution for an arbitrary χ. Thus one solves the relativistic analogue of the classical problem, *viz.*, "to find the body when the potential is given." It may be noted that $e^{\nu/2}$ plays the part of the Newtonian potential to the first order of approximation for masses.

As a differential equation in ν (8) assumes the form,

$$z'' P + \tfrac{1}{2} z' P' + \left(\frac{P'}{2r} + \frac{1}{r^4}\right) z = o \tag{8.2}$$

where $$z = e^{\nu/2}, \quad P = \frac{1}{r^2} - \frac{2m}{r^3}. \tag{14}$$

It may be remarked at the outset that for suitably chosen values of p (8.2) admits of integration by series. On changing the independent variable from r to θ so that

$$\theta'^2 P = 1 \tag{15}$$

(8.2) is reduced to

$$\frac{d^2 z}{d\theta^2} + Hz = o \tag{8.3}$$

where $$H = \frac{P'}{2r} + \frac{1}{r^4} = -\frac{1}{r}\frac{d}{dr}\left(\frac{m}{r^3}\right) \tag{16}$$

$$= \frac{1}{r^4} - \frac{\theta''}{\theta'^3 r} = \frac{1}{r^4} + \frac{1}{r}\frac{d^2 r}{d\theta^2}. \tag{16.1}$$

A number of particular solutions of (8.3) may be given.

Case (i): $H = o$, $P = \frac{1}{r^2} - 2\alpha$ where α is a constant.

$$\frac{dr}{d\theta} = \left(\frac{1}{r^2} - 2\alpha\right)^{1/2}.$$

$$z = A + B\theta = A - \frac{B}{2\alpha}(1 - 2\alpha r^2)^{1/2} \tag{17}$$

where A and B are constants. This corresponds to Schwarzschild's solution :

$$8\pi\rho = 6\alpha$$

$$8\pi p = \frac{3B(1-2\alpha r^2)^{\frac{1}{2}}-2\alpha A}{A-B(1-2\alpha r^2)^{\frac{1}{2}}/2\alpha}.$$

Case (ii): $H=\pm B^2$ where B is a constant. Here

$$z=A_1 e^{B\theta}+A_2 e^{-B\theta} \quad (18.1)$$

$$\text{or} \quad z= A_1 \cos B\theta + A_2 \sin B\theta \quad (18.2)$$

where A_1 and A_2 are constants of integration.

In this case

$$-\frac{1}{r}\frac{d}{dr}\left(\frac{m}{r^3}\right) = \pm B^2 ,$$

$$\frac{m}{r^3} = \mp\frac{B^2 r^2}{2}+c,$$

$$m' = 4\pi\rho r^2 = \mp\frac{5B^2 r^4}{2}+3cr^2,$$

$$\text{or } 4\pi\rho = \mp\frac{5B^2 r^2}{2.}+3c$$

where c is obviously the constant of integration. The relation between θ and r is given by

$$\left(\frac{dr}{d\theta}\right)^2 = \frac{1}{r^2}\pm B^2 r^2 - 2c \quad .$$

The pressure is given by (2) :

$$8\pi p = e^{-\lambda}\left(\frac{\nu'}{r}+\frac{1}{r^2}\right)-\frac{1}{r^2}$$

$$=\left(1-\frac{2m}{r}\right)\frac{1}{r}.\frac{2z'}{z}-\frac{2m}{r^3}$$

$$=\left(1-\frac{2m}{r}\right)\frac{2}{r}.\frac{1}{z}.\frac{dz}{d\theta}\frac{r}{(1-2cr^2\pm B^2 r^4)^{1/2}}-\frac{2m}{r^3}$$

For $H=B^2$,

$$B\theta = \tfrac{1}{2}\sinh^{-1}\left[\frac{B^2 r^2-c}{(B^2-c^2)^{1/2}}\right]+D \text{ or } \tfrac{1}{2}\cosh^{-1}\left[\frac{B^2 r^2-c}{(c^2-B^2)^{1/2}}\right]+D$$

according as $B >$ or $< c$. D is an arbitrary constant.

For $H=-B^2$,

$$B\theta = \tfrac{1}{2}\sin^{-1}\left[\frac{B^2 r^2-c}{(B^2+c^2)^{1/2}}\right]+D.$$

Case (iii): $H = (k^2 - \frac{1}{4})\frac{1}{\theta^2}$ and $\theta = kr^2$ where k is a constant.

$$z = A_1 r^{1-n} + A_2 r^{1-n} \tag{19}$$

where $4k^2 = 2 - n^2$

and A_1 and A_2 are arbitrary constants of integration. The density and pressure are given by

$$P = \frac{1}{r^2} - \frac{2m}{r^3} = \left(\frac{dr}{d\theta}\right)^2$$

or

$$\frac{2m}{r^3} = \frac{1-n^2}{2-n^2}\frac{1}{r^2};$$

thus

$$8\pi\rho = \frac{1-n^2}{2-n^2}\frac{1}{r^2}$$

and $$8\pi\rho = \left(1 - \frac{2m}{r}\right)\frac{1}{r}\frac{2z'}{z} - \frac{2m}{r^3}$$

$$= \left(1 - \frac{2m}{r}\right)\frac{1}{r}\cdot\frac{2\{A_1 r^{-n}(1-n) + A_2 r^n(1+n)\}}{A_1 r^{1-n} + A_2 r^{1+n}} - \frac{2m}{r^3}$$

$$= \left(1 - \frac{2m}{r}\right)\frac{2\{A_1(1-n) + A_2(1+n)r^{2n}\}}{A_1 r^2 + A_2 r^{2+n}} - \frac{2m}{r^3}.$$

Case (iv): $H = \frac{1}{k^4}\frac{1}{\theta^4}$ if $r = k\theta$, where k is a constant.

$$z = \frac{r}{k}\left(A_1 \cos\frac{1}{kr} + A_2 \sin\frac{1}{kr}\right) \tag{20}$$

where A_1 and A_2 are constants of integration. In this case,

$$\frac{2m}{r^3} = \frac{1}{r^2} - k^2,$$

$$8\pi P = \frac{1}{r^2} - 3k^2,$$

$$8\pi p = -\frac{2m}{r^3} + \left(1 - \frac{2m}{r}\right)\frac{2}{r}\times$$

$$\frac{\left(A_1 \cos\frac{1}{kr} + A_2 \sin\frac{1}{kr}\right) - \frac{1}{kr}\left(A_2 \cos\frac{1}{kr} - A_1 \sin\frac{1}{kr}\right)}{r\left(A_1 \cos\frac{1}{kr} + A_2 \sin\frac{1}{kr}\right)}.$$

Case (v) $H = \frac{3}{16\theta^2(\theta-1)^2}$ when $r^2 = \frac{4}{\sqrt{7}}\theta(\theta-1)$. In this case

$$z = A_1\theta^{3/4}(\theta-1)^{1/4} + A_2\theta^{1/4}(\theta-1)^{3/4}. \tag{21}$$

The density is obtained from the equation

$$\frac{1}{r^2}-\frac{2m}{r^3}=\left(\frac{dr}{d\theta}\right)^2$$

so that

$$8\pi\rho=\frac{3}{7r^2}-\frac{12}{\surd 7}\,.$$

The pressure is given by

$$8\pi p=-\frac{2m}{r^3}+\left(1-\frac{2m}{r}\right)\frac{A_1\theta^{1/2}(4\theta-3)+A_2\ (\theta-1)^{1/2}(4\theta-1)}{r^2(2\theta-1)\ (A_1\theta^{1/2}+A_2\ (\theta-1)^{1/2})}$$

where

$$\theta=\tfrac{1}{2}\{1+(\surd 7r^2+1)^{1/2}\}.$$

A_1 and A_2 are arbitrary constants as in the other cases.

Case (vi): One solution can be obtained by using the method of finding the integrating factor. $f(r)$ is an integrating factor for (8.2) provided

$$f''P+\frac{3}{2}\ f'P'+f\left(\frac{1}{r^4}+\frac{P'}{2r}+\frac{1}{2}\ P''\right)=o.$$

Suppose that P is such that

$$\frac{1}{r^4}+\frac{P'}{2r}+\frac{1}{2}\ P''=o \tag{23}$$

giving

$$\frac{2m}{r}=\frac{3}{2}\frac{1}{r^2}+A_1\ \log r+A_2$$

or

$$8\pi\rho=\frac{3}{2}\ \frac{1}{r^2}+3A_1\ \log r+A_1+3A_2$$

where A_1 and A_2 are arbitrary constants. $f\ (r)$ is given by

$$f'=KP^{-3/2}$$

where K is a constant of integration. From this follows the value of z:

$$z=\text{const.}\quad (Pf)^{1/2}.$$

The expression for pressure can be readily evaluated :

$$8\pi p=-\frac{2m}{r^3}+\left((1-\frac{2m}{r}\right)\frac{1}{r}\left[\frac{P'}{P}+\frac{P^{-3/2}}{\int-(\frac{1}{2r^2}-A_1\log r-A_2)^{-3/2}dr}\right].$$

Sometimes the method of finding the integrating factor leads to interesting solutions subject to particular restrictions. For example, the condition for r^n to be an integrating factor of

$$z''\left(1-\frac{2m}{r}\right)^{1/2}+z'\left[\frac{d}{dr}\left(1-\frac{2m}{r}\right)^{1/2}-\frac{1}{r}\left(1-\frac{2m}{r}\right)^{1/2}\right]+z$$

$$\left[\frac{d}{dr}\left\{\frac{\left(1-\frac{2m}{r}\right)^{1/2}}{r}\right\}+\frac{1}{r^2\left(1-\frac{2m}{r}\right)^{1/2}}\right]=o$$

which is (8.2) in another form is fulfilled if $1 - \frac{2m}{r} = \frac{1}{n^2-2}\left(\frac{A}{r^p} - 1\right)$

where $$p = \frac{2\,(n^2-2)}{n+2} \quad .$$

Several particular solutions of interest follow from this for varying values of n.

3. The Isotropic Solution in Successive Approximations

Here we start with the equation of isotropy, (8.2), written in the form:

$$\frac{z''}{r^2} - \frac{z'}{r^3} = 2z''\,x + z'\,x' + \frac{1}{r}\,x'\,z \tag{8.4}$$

where $$x = \frac{m}{r^3} \quad .$$

The density ρ appears through x and x'. To the first order of ρ we have

$$z = 1 + a_1 + \int_0^r \frac{m}{r^2}\,dr + c_1\,\frac{r^2}{2} \tag{24}$$

where a_1 and c are constants of the order of ρ. All terms involving ρ^2 and higher powers have been neglected in deriving (24). This means that the latter is actually the solution of

$$\frac{z''}{r^2} - \frac{z'}{r^3} = \frac{1}{r}\,x' \tag{25}$$

z being assumed to be such that its value is unity when ρ vanishes. As determined by the boundary conditions, *viz.*, the continuity of $g_{\mu\nu}$ and the vanishing of p at the surface of the sphere $(r=a)$,

$$a_1 = -\frac{m_0}{a} - \int_0^a \frac{m}{r^2}\,dr, \qquad c_1 = o \quad . \tag{26}$$

It is well-known that for $r > a$ the field is described by

$$ds^2 = -\left(1 - \frac{2m_0}{r}\right)^{-1} dr^2 - r^2\,(d\,\theta^2 + \sin^2\theta\,d\,\phi^2) + \left(1 - \frac{2m_0}{r}\right)dt^2 \tag{27}$$

where $m_0 = m(a)$.

Carrying the computations to the second order of the density we get

$$z = (1 + a_1)\left(1 + \int_0^r \frac{m}{r^2}\,dr\right) + a_2 + \tfrac{1}{2}\,c_2 r^2$$

$$+ \frac{5}{2}\int_0^r \frac{m^2}{r^3}\,dr - r^2\int_0^r \frac{m^2}{r^5}\,dr + \int_0^r \frac{m}{r^2}\,dr \int \frac{m}{r^2}\,dr. \tag{28}$$

The constants of integration are a_2 and c_2 at this stage and they are determined as before by using the boundary conditions :

$$a_2 = -\tfrac{1}{2}\frac{m_0^2}{a^2} - a_1\int_0^a \frac{m}{r^2}\,dr - \frac{5}{2}\int_0^a \frac{m^2}{r^3}dr + \tag{29}$$

$$+\,a^2\int_0^a \frac{m^2}{r^5}\,dr - \int_0^a \frac{m}{r^2}\,dr\int_0^r \frac{m}{r^2}\,dr + \tfrac{1}{2}\,c_2\,a^2;\; c_2 = \frac{m_0^2}{2a^4} + 2\int_0^a \frac{m^2}{r^5}\,dr. \tag{30}$$

Even at the second stage the relativistic effect does not appear prominently in the field expressions. For example, the expression for pressure obtained at this stage agrees exactly with the classical expression signifying that the relativistic effect on pressure is nil so far as these calculations go. Going a stage further we get

$$
\begin{aligned}
z = 1 + a_1\Big[1 + \int_0^r \frac{m}{r^2}\,dr + \frac{5}{2}\int_0^r \frac{m^2}{r^3}\,dr - r^2\int_0^r \frac{m^2}{r^5}\,dr + \int_0^r \frac{m}{r^2}\int_0^r \frac{m}{r^2}\,dr dr\Big] \\
+ a_2\Big[1 + \int_0^r \frac{m}{r^2}\,dr\Big] + a^3 \\
+ c_2\Big[\tfrac{1}{2}\,r^2 + 2\int_0^r m dr - \frac{r^2}{2}\int_0^r \frac{m}{r^2}\,dr\Big] + \tfrac{1}{2}\,c_3\,r^2 \\
+ \int_0^r \frac{m}{r^2}\,dr \\
+ \frac{5}{2}\int_0^r \frac{m^2}{r^3}\,dr - r^2\int_0^r \frac{m^2}{r^5}\,dr + \int_0^r \frac{m}{r^2}\int_0^r \frac{m}{r^2}\,dr\,dr \\
+ \frac{21}{4}\int_0^r \frac{m^3}{r^4}\,dr - \frac{11}{4}\,r^2\int_0^r \frac{m^3}{r^6}\,dr + \int_0^r \frac{m}{r^2}\int_0^r \frac{m}{r^2}\int_0^r \frac{m}{r^2}\,dr\,dr\,dr \\
+ \frac{5}{2}\int_0^r \frac{m}{r^2}\int_0^r \frac{m^2}{r^3}\,dr\,dr \\
+ \int_0^r r\int_0^r\left(\frac{5m}{r^2} - \frac{3m'}{r}\right)\int_0^r \frac{m^2}{r^5}\,dr\,dr\,dr \\
+ \int_0^r r\int_0^r\left(\frac{3mm^1}{r^4} - \frac{8m^2}{r^5}\right)\int_0^r \frac{m}{r^2}\,dr\,dr\,dr.
\end{aligned}
\tag{31}
$$

The constants a_3 and c_3 can be determined as before. We have for pressure the expression,

$$8\pi p = \frac{1}{r}\left(1-\frac{2m}{r}\right)\frac{2z'}{z} - \frac{2m}{r^3} \tag{32}$$

which can be calculated using the value of z given above. To the second order of ρ we find

$$8\pi p = 2c_2 - \frac{m^2}{r^4} - 4\int_0^r \frac{m^2}{r^5}\,dr. \tag{33}$$

Using (2), (5.1) and (6.1) one obtains a direct relation between p and ρ. This is a differential equation of Riccati's type[3]. It runs as follows:

$$p'\left(1-\frac{2m}{r}\right) + p\left(\frac{m}{r^2}+\frac{m'}{r}\right) + 4\pi p^2 r + \frac{mm'}{4\pi r^4} = 0. \tag{34}$$

It is clear that, if the third order terms are neglected in the left-hand side the Newtonian equation,

$$p' + \frac{mm'}{4\pi r^4} = 0, \tag{35}$$

results. If the last term, involving p^2, is neglected we have

$$p\, e^{\int_0^r \frac{\frac{m}{r^2}+\frac{m'}{r}}{1-\frac{2m}{r}}dr} + \int_0^r \frac{mm'}{4\pi r^4\left(1-\frac{2m}{r}\right)} e^{\int_0^r \frac{\frac{m}{r^2}+\frac{m'}{r}}{1-\frac{2m}{r}}dr} + A = 0 \tag{36}$$

where A is an arbitrary constant. If p_0 is the Newtonian value as given by (33) we find p correct to the third order by substituting p_0 for p in the third term of (34) before doing the integration. It is to be noted that the form (34) or the integral obtained therefrom does not permit the equation of state to be formulated in the usual form[4]

$$\rho = f(p). \tag{37}$$

The equation (34) may alternatively be written as

$$4\pi r^2\rho + \frac{d}{dr}\left\{\frac{r^2.\, 4\pi pr\,(p+\rho) + p'}{p+\rho-2rp'}\right\} = 0. \tag{34.1}$$

This much is certain that at $r=a$ where $p=0$, p' is negative unless $\rho=0$ also in which case $p'=0$.

4. Particular Radial Distributions of Interest

It is worth while considering a radial distribution characterised by $T_1^1=0$, $T_2^2 \mp 0$. In this case the condition on T_1^1 gives

$$\nu' = \frac{2m}{r^2\left(1-\frac{2m}{r}\right)} \tag{38}$$

and $$\nu = \int_0^r \frac{2m}{r^2\left(1-\frac{2m}{r}\right)}\, dr; \tag{39}$$

the constant of integration can be absorbed in the time-coordinate and can be taken as zero without any loss of generality. Using the values of λ and ν as given by (6.1) and (39) one finds

$$-8\pi T_2^{\ 2} = 8\pi q = \frac{mm'}{r^3\left(1-\frac{2m}{r}\right)} = \frac{4\pi mp}{r\left(1-\frac{2m}{r}\right)}$$

or $$q = \frac{1}{2}\,\frac{mp}{r\left(1-\frac{2m}{r}\right)}\,. \tag{40}$$

The transverse pressure q has a special significance, particularly, in the absence of radial pressure. It is due to the random motion of matter on concentric spherical surfaces. The statistical relation between the pressure and density is

$$q = \tfrac{1}{2}\, p\, v^2$$

where v is the velocity of random motion along the surface of radius r. Therefore

$$v^2 = \frac{m}{r\left(1-\frac{2m}{r}\right)}\,. \tag{41}$$

The Newtonian analogue of this is

$$v^2 = \frac{m}{r}\,. \tag{41.1}$$

Thus the line-element,

$$ds^2 = -\left(1-\frac{2m}{r}\right)^{-1} dr^2 - r^2\left(d\theta^2 + \sin^2\theta\, d\phi^2\right) + e^{\int_0^r \frac{2m\, dr}{r^2\left(1-\frac{2m}{r}\right)}}\, dt^2, \tag{42}$$

where

$$m = \int_0^r 4\,\pi r^2\, \rho\, dr\,,$$

gives us the field of a spherical distribution of matter, the motion at a distance r being circular and on the sphere of radius r about the origin. ρ is left arbitrary.

One may enquire next whether a static spherical distribution is possible so that

$$T_2^{\ 2} = o,\ T_1^{\ 1} \leqslant o\,. \tag{43}$$

Since $q = o$, (5) reduces to

$$p' + (\rho + p)\nu'/2 + 2p/r = o \tag{5.2}$$

where $$\nu' = \frac{8\pi pr + \frac{2m}{r^2}}{1-\frac{2m}{r}}\,. \tag{44}$$

From (5.2) and (44) follows

$$p'r^2+2pr+\frac{(p+\rho)\ (4\pi pr^3+m)}{1-\frac{2m}{r}}=0 \tag{45}$$

The Newtonian analogue of (45) is

$$p'r^2+2pr+mp=0 \tag{45.1}$$

as is to be expected. There is a special interest in the case

$$p=\frac{k}{r^2} \tag{46}$$

when (45) simplifies into

$$(pr^2)'+\frac{4\pi(pr^2+k)^2}{r(1-8\pi k)}=0, \tag{45.2}$$

k being a constant. Hence

$$p=\frac{1}{r^2}\left[\frac{1-8\pi k}{4\pi\ \log r}-k\right] \tag{47}$$

and the radius a of the sphere is given by

$$\log a=\frac{1}{4\pi k}-2. \tag{48}$$

It is evident that k must be subject to the condition

$$8\pi k<1.$$

The total mass of the sphere is given by

$$m\ (a)=4\pi ka. \tag{49}$$

The value of ν follows from (44). It is

$$\nu=\log\left[\frac{(\log r)^2}{c}\right] \tag{50}$$

and the value of c is determined by the condition of continuity for g_{44} at $r=a$. Referring to (27) we get

$$c=1-8\pi k. \tag{51}$$

The line-element is now of the form

$$ds^2=-(1-8\pi k)^{-1}\ dr^2-r^2\ (d\theta^2+\sin^2\theta d\phi^2)+\frac{(\log r)^2}{1-8\pi k}\ dt.^2 \tag{52}$$

We have shown here how the relativistic field can be obtained for radial distributions in statistical equilibrium the motion being to and fro between the centre and the surface. ρ can be taken as perfectly arbitrary in (45).

Consider lastly the particular case

$$p=q,\quad kp=\rho \tag{5.3}$$

where k is a positive constant less than 3. $k=3$ corresponds to the case of radiation. The field is now subject to the conditions

$$p'=-\frac{k+1}{2}p\,\nu', \tag{5.3}$$

$$e^{-\lambda}=1-\frac{2m}{r} \tag{56.1}$$

and
$$\nu' = \frac{8\pi \frac{r}{k} p + \frac{2m}{r^2}}{1 - \frac{2m}{r}} \quad . \tag{44.1}$$

Eliminating ν' between (5.3) and (44.1) we get

$$\frac{8\pi \frac{r}{k} p + \frac{2m}{r^2}}{1 - \frac{2m}{r}} = -\frac{2}{k+1}\frac{\rho'}{\rho} = -\frac{2}{k+1}\frac{p'}{p} \tag{54}$$

For the solution to be physically tenable it is necessary to assume that

$$\frac{2m}{r} < 1 \quad . \tag{55}$$

Then (54) shows that p must be a steadily decreasing function of r. As (54) does not admit of integration one may try to arrive at some general conclusion about such distributions in the light of the restrictions on p and ρ. At $r=a$, $p=o$ and similarly $\rho=o$ and $p'=o$ also in this case. The behaviour of ρ at this surface will be given fairly approximately by

$$\frac{2m_0}{r^2\left(1 - \frac{2m_0}{r}\right)} = -\frac{2}{k+1}\frac{\rho'}{\rho} \quad or \quad 1 - \frac{2m_0}{r} = A\rho^{-\frac{2}{k+1}} \quad , \tag{56}$$

where A is a constant. (56) does not accord with the expected behaviour at $r=a$. Hence there cannot exist a finite material distribution of the kind (53) bounded by a finite surface of zero pressure. It can be shown that infinite spheres of this kind exist for permissible values of k. Thus no amount of radiation can be in relativistic equilibrium within a sphere of finite radius, under the natural forces of gravitation.

5. The Energy of a Spherical Distribution

The topic of the energy of a spherical distribution has not yet been properly discussed and certain crucial questions remain to be tackled. Consider a field given by

$$ds^2 = -Ae^{\lambda}dr^2 - Be^{\mu}r^2(d\theta^2 + \sin^2\theta d\phi^2) + Ce^{\nu}dt \tag{57}$$
$$\lambda = \lambda(r), \ \mu = \mu(r), \ \nu = \nu(r)$$

for $r \leqslant a$ *and*

$$ds^2 = -\left(1 - \frac{2m_0}{r}\right)^{-1}dr^2 - r^2(d\theta^2 + \sin^2\theta d\phi^2) + \left(1 - \frac{2m}{r}\right)dt^2 \tag{27}$$

for $r \geqslant a$. It is supposed that A, B, C, are constants such that

$$Ae^{\lambda(a)} = \left(1 - \frac{2m_0}{a}\right)^{-1}, \ Be^{\mu(a)} = 1, \ Ce^{\nu(a)} = 1 - \frac{2m_0}{a} \quad . \tag{58}$$

The question that confronts us is, Is the material distribution represented by (57) one which has the energy m_0? This is a pertinent question, for the external field corresponding to the material distribution

of (57) is supposed to be the same as that of a particle of mass m_0. λ, μ, ν are arbitrary functions of r and the constants A, B, C are chosen so as to satisfy the conditions of continuity (58). If the answer to the question is in the affirmative it should be possible to prove that the internal energy of a material distribution is exclusively expressible in terms of the surface values of $g_{\mu\nu}$ either generally, or for the form (57). We are not interested so much in a particular form as in the most general case. It has nowhere been proved that the surface values of $g_{\mu\nu}$ determine the total internal energy. Hence it follows that either the continuity of $g_{\mu\nu}$ must be shown to be enough or some additional conditions be formulated to make the energy corresponding to (57) to be m_0. We are satisfied that the continuity of $g_{\mu\nu}$ is not enough. The general expression for the internal energy, as given by Tolman, is

$$m_0 = \iiint \tfrac{1}{2}\left(T^4_4 - T^1_1 - T^2_2 - T^3_3\right)\sqrt{-g}\,dxdy\,dz$$
$$+\frac{1}{16\pi}\iiint\left[\frac{\partial}{\partial x}(F_\alpha\,\beta,1)+\frac{\partial}{\partial y}(F_\alpha\,\beta,2)+\frac{\partial}{\partial z}(F_\alpha\,\beta,3)\right]dx\,dy\,dz$$
$$+\frac{1}{16\pi}\iiint g^{\alpha\beta}\sqrt{-g}\frac{\partial}{\partial t}(H_\alpha\,\beta,4)\,dx\,dy\,dz \qquad (59)$$

where $$F_\alpha\,\beta, l = g^{\alpha\beta}\sqrt{-g}\left\{-\Gamma^{l}_{\mu\nu}+\tfrac{1}{2}g^{l}_{\mu}\Gamma^{\beta}_{\nu\beta}+\tfrac{1}{2}g^{l}_{\nu}\Gamma^{\beta}_{\mu\beta}\right\} \qquad (60)$$

and $$H_\alpha\,\beta, 4 = -\Gamma^{4}_{\mu\nu}+\tfrac{1}{2}g^{4}_{\mu}\Gamma^{\beta}_{\nu\beta}+\tfrac{1}{2}g^{4}_{\nu}\Gamma^{\beta}_{\mu\beta}. \qquad (61)$$

We have not actually evaluated (59) for the line-element (57). But in the simpler case, which has been discussed throughout when the field is expressed in the isotropic form, *viz.*,

$$ds^2 = -e^{\chi}(dx^2+dy^2+dz^2)+e^{\nu}dt^2 \qquad (62)$$

$$\chi=\chi(r),\ \nu=\nu(r)$$

we get from (59) or the simpler result,

$$m_0 = \int (\rho+3p)\sqrt{-g}\,dxdydz \qquad (63)$$

that $$\left[e^{\chi/2} r^2 e^{\nu/2}\tfrac{1}{2}\nu'\right]_{r=o}^{r=a'} = m_0 \qquad (64)$$

This can be expressed also in the form

$$\left[\frac{1}{e^{\chi/2}}\frac{\partial}{\partial r}\left(e^{\nu/2}\right)\cdot 4\pi\left(re^{\chi/2}\right)^2\right]_o^{a'} = 4\pi m_0 \qquad (64.1)$$

which is suggestive of the Gauss Theorem.[7] Transforming it for the line-element (1) we get

$$\left[\frac{1}{e^{\lambda/2}}\frac{\partial}{\partial r}\left(e^{\nu/2}\right)4\pi r^2\right]_o^{a} = 4\pi m_0. \qquad (65)$$

$r=a$ in one co-ordinate system is supposed to correspond to $r=a'$ in the other. It is obvious from the last result that a derivative of $g_{\mu\nu}$ at the boundary may affect the value of the total internal energy. In other words, the total internal energy for a line-element of the form (1) is not expected to depend upon the boundary values of $g_{\mu\nu}$ alone.

Yet our calculations proved that in all the cases considered by Tolman on the basis of the continuity of $g_{\mu\nu}$ only no discord arises whether the energy is assessed from the continuity or from a general formula such as (59). This seemed very puzzling. Ultimately we discovered that the condition (65) which arises from (59) is *accidentally* equivalent to the condition for p to be zero at the boundary as (44) shows. The root of possible discord disappears in the particular case of (1) through this peculiarity in the behaviour of p.

Incidentally it may be mentioned that the condition (65) is simpler to work with than the condition, $p=0$ *at* $r=a$, in order to determine the constants of integration. For example, (30) can be easily obtained from (65).

Finally, we should like to place on record our thanks to Professor V. V. Narlikar who suggested the problem and made valuable suggestions at different stages during the course of the investigation.

Abstract

Several new solutions of Einstein's field equations having possible astronomical applications are obtained. Many of Tolman's new solutions are derived by adopting a more general procedure. The equation of isotropy is integrated in one particular form. A perfectly general solution for a static spherical distribution is given correct to the third order of the density. The question of the energy of such distributions is considered and conclusions which are both new and significant regarding the energy of heterogeneous spheres are arrived at.

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BENARES HINDU UNIVERSITY
BENARES

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THE CRITICAL SHEAR STRESS

By

MOHAMED SALEH QURAISHY

ABSTRACT

IN this paper we propound a theory of the transport of sediment by fluid currents, specially by flowing water, by supposing that when in motion the force impressed upon a sand layer by the moving fluid is proportional to the force exerted on the particles by their own weight, when falling freely in a stationary fluid column. We justify the adoption of this hypothesis by studying the behaviour of the moving particles. We then calculate the impressed force from the conception of momentum loss and establish that for general motion the pure number $\tau_c/P_w V_s^2$ is a function of either $U\tau_c k/\nu$ or $V_s k/\nu$. Here τ_c is the critical shear stress at the bed, $U\tau_c$ $(=\sqrt{\tau_c/P_w})$ the critical shear velocity, V_s the terminal velocity of the particles, k the mean grain diameter of the particles, P_w the fluid density and ν the kinematic viscosity of the fluid. We find the theoretical results highly in accord with experimental results of varied nature.

1. INTRODUCTION

We have often to construct hydraulic models where, so as to simulate natural phenomena, it is in general necessary to use some granular material. The choice of the material is, in the main, governed by the model scale adopted, which in turn is mostly fixed from experience. From experience it is also found that the model results approximate fairly closely to the prototype phenomena if the topmost sediment layer alone is, partially or wholly, in motion. The hydraulic quantities such as shear stress at the bed, water discharge, etc., are then called *threshold* or *critical* quantities, whereas the relations in which these are correlated with the sediment characteristics are called threshold or critical relations.

The derivation of such relations has for long been the subject of intensive investigation, both theoretical and experimental, and the subject occupies a highly important position in hydraulics. Of these, the relation for the shear stress is favoured most and for its derivation the theoretical treatment generally employed, is to equate the fluid pressure $\frac{\pi}{4}k^2 \frac{P_w}{2} U^2$ to the particle weight $(P_s - P_w)\, g \frac{\pi}{6} k^3$ (k is the grain diameter and P_s and P_w are the densities of the particle material and the fluid respectively) and then substitute for the local velocity U a value so as to get the required relation. For example, by substituting for U the value from PRANDTL-KÁRMÁN logarithmic velocity formula, we find $\tau_c/(P_s - P_w)\, g\, k$ as a function of $U\tau_c k/\nu$ (SHIELDS 1936). Here τ_c is the

shear stress at the bed, $U\tau_c$ called the shear stress velocity, is equal to $\sqrt{\tau_c/\rho_w}$, and ν is the kinematic viscosity of the fluid. However, the derivation is based on an argument that logically fails to be applicable to any but the *static equilibrium* condition of the particles, *i.e.*, at the most to the condition when the particles are *about* to be set in motion. Even then, contrary to the forecast, the correlation of data, plotted on the basis of $\tau_c/(\rho_s-\rho_w)\,g\,k$ against the Reynolds Number $U\tau_c k/\nu$ is, from many points of view, seen to be unsatisfactory.

In this paper I present an alternative viewpoint and formulate a theory which is free from such objections and is further capable of great extensions. Here however I derive the functional relations for the critical shear stress only and show that the theoretical results agree well with experiment.

2. A Simplifying Assumption and its Justification

In the present theory we adopt a hypothesis which may be enunciated simply as follows : *The force impressed on a sand layer by the moving fluid is proportional to the force exerted on the particles by their own weight, when falling freely in a stationary fluid column.* The hypothesis is seen to be supported by the actual behaviour of the particles, which when in motion, are seen to trace out steps or make gentle leaps. This we may guess is due to the particles receiving impacts from the molar masses of the moving fluid.* Such blows impart motion to the particles and as the blows are irregular, each path, though apparently straight, may consist of short zig-zag paths. These we may suppose to be traced out with the same speed appropriate to the individual particles, and maintained as such by the collisions of the molar masses of the moving fluid.

If now the particle P (fig. 1) receives a bump, it bounces off to a height h. This is the maximum height to which the particle rises and generally



Fig. 1. Illustrating the Trajectory of a Particle

it is small compared with its size. So that, the path AB will be approximately a straight line parallel to the bed. We could now so define the intensity of motion that we have a single sediment layer, one grain thick, moving in the flow direction. The grains of this monolayer are understood to be freely moving in the flow direction, *i.e.*, there is no mutual interaction between them. Below this layer is an immobile or nearly immobile layer with *similar grain distribution* as in the mobile monolayer, the two being separated from one another by perhaps an infinitesimally thin layer of fluid : a simple assumption the validity of which is hardly beyond experimental investigation.

* There is hardly any connection between this action and that described by R. A. BAGNOLD (1935), according to whom, in air currents there is mutual bombardment of the particles. In water channels, such an action will be likely if the slopes are very steep and the sediment motion fairly strong. We however exclude such experimental data, if at all existing.

The momentum communicated by the stationary grains sustains the particles in the fluid, whereas the gravitational force tends to draw the particles towards the bed. The actual state of the particles depends upon the balancing of these two forces. So that, under equilibrium conditions, the extraneous force proportional to $P_w V_s^2 \psi(V_s k/\nu)$ is equal to that due to the momentum communicated, from which we conclude that the use of the hypothesis is justified.

3. The Force Impressed by the Moving Fluid

To calculate the momentum communicated we follow Th. von Kármán (1921). Consider then a typical section of a rough but flat bed surface. Let this be of unit width but dx long, and in fig. 2 let it be represented by BB^1. Let AA^1 be the outer limit of the boundary layer of a definite thickness δ ; let AB and A^1 B^1 be the normals to the bed at the two extremities of dx ; let U_1 be the velocity outside the boundary

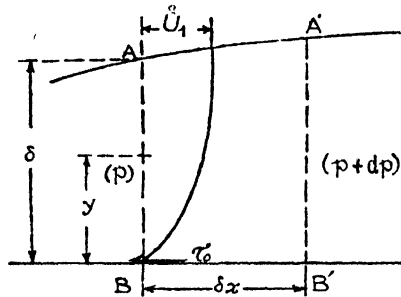


Fig. 2. Loss of Momentum over a Sand Layer

layer in the flow direction. Then the flux of fluid across B^1 A^1 per unit time exceeds that across BA by

$$dx \frac{\partial}{\partial x} \int_{y_1}^{\delta} P_w U dy, \qquad \ldots\ldots (3.1)$$

where y_1 is the arbitrary distance, inwards from the bed, where the velocity is presumed to be zero. It has the general form

$$y_1 = \frac{\alpha \nu}{U\tau_o} \Psi \left\{ \left(\frac{U\tau_o k}{\nu} \right), \frac{k}{b}, kbn \right\}, \ldots\ldots (3.2)$$

where

α = constant,

$\nu = \mu / P_w$ = kinematic viscosity of the fluid,

k = grain size at right angles to the flow direction,

b = grain width at the base,

and n = number of grains per unit area.

The quantity k/b is the 'average aspect ratio' and its influence may partly be accounted for by the terminal velocity V_s, whereas the influence of kbn, called the packing co-efficient, is overcome by restricting the data to *general motion*, which is identified with that stage of movement when all the sediment sizes are in motion and the movement is strong enough to develop bed configurations. The moving particles, supposed to have *similar grain distribution* to those in the immobile layer immediately below, are free to move in the medium under the influence of the impressed force and such forces, as might arise by their collision with other stationary or nearly stationary grains, are negligible. The equality then reduces to the simpler form

$$y_1 = \frac{\alpha\nu}{U\tau_o}\Psi\left(\frac{U\tau_o k}{\nu}\right). \qquad \ldots\ldots \quad (3.3)$$

The flux given by (3.1) is also the inward flux across AA^1. The fluid crossing AA^1 has velocity U_1 in the x-direction, and so the inward flux of momentum across AA^1 is

$$U_1\,dx\frac{\partial}{\partial x}\int_{y_1}^{\delta} P_w\,U\,dy, \qquad \ldots\ldots \quad (3.4)$$

so that, the net outward flux of momentum is

$$dx\left\{\frac{\partial}{\partial x}\int_{y_1}^{\delta} P_w\,U^2 dy - U_1\frac{\partial}{\partial x}\int_{y_1}^{\delta} P_w\,U\,dy\right\}. \qquad \ldots\ldots \quad (3.5)$$

The rate of change of momentum inside BAA^1B^1, considered as a fixed surface, is

$$dx\int_{y_1}^{\delta} P_w\frac{\partial U}{\partial t}\,dy, \qquad \ldots\ldots \quad (3.6)$$

whilst the forces acting on the fluid in the x-direction are the drag $-\tau_o$, and the difference of pressure on BA and B^1A^1, $\delta\left(\frac{\partial p}{\partial x}\right)dx$. Hence

$$\int_{y_1}^{\delta} P_w\frac{\partial U}{\partial t}dy + \frac{\partial}{\partial x}\int_{y_1}^{\delta} P_w U^2 dy - U_1\frac{\partial}{\partial x}\int_{y_1}^{\delta} P_w U dy = -\delta\frac{\partial p}{\partial x} - \tau_o \ldots (3.7)$$

For steady flow in which U_1 is independent of x, as here considered, and $\partial U/\partial t = 0$, this equation reduces to

$$\tau_o = \frac{\partial}{\partial x}\int_{y_1}^{\delta} P_w\,(U_1 - U)\,U\,dy. \qquad \ldots \quad (3.8)$$

This may also be written as

$$\tau_o = \frac{\partial}{\partial x} \int_{y_1}^{\delta} P_w U_1^2 \left(1 - \frac{U}{U_1} \right) \cdot \frac{U}{U_1} \, dy. \qquad \ldots\ldots (3.9)$$

Put now

$$U/U\tau_o = f = \frac{1}{\epsilon} \log_e \left(\frac{y}{y_1} \right), \qquad \ldots\ldots (3.10)$$

and

$$U_1/U\tau_o = f_1 = \frac{1}{\epsilon} \log_e \left(\frac{\delta}{y_1} \right), \qquad \ldots\ldots (3.11)$$

where ϵ is a universal constant having a numerical value $\backsim$ 0.40 Then (3.9) becomes

$$\tau = \frac{\partial}{\partial x} \int_{y_1}^{\delta} P_w U_1^2 \left(1 - \frac{f}{f_1} \right) \left(\frac{f}{f_1} \right) dy \qquad \ldots\ldots (3.12)$$

Introducing

$Y = y/k$, and $Y_1 = \delta/k$, we have $dY = dy/k$,
and therefore

$$\tau_o x = P_w U_1^2 \int_{y_1/k}^{\delta/k} \left\{ \frac{f}{f_1} - \left(\frac{f}{f_1} \right)^2 \right\} k \, d\,Y,$$

$$= P_w U_1^2 \, k \, F_1 \left(Y_1, \frac{y_1}{k} \right),$$

i.e.,

$$\tau_o \, x = P_w U_1^2 \, k \, F_2 \left(\frac{\delta}{k} \right). \qquad \ldots\ldots (3.13)$$

4. Critical Shear Stress Functions in Theory

Then considering unit width of the mobile monolayer, nk in length, it follows that

$$1 \cdot nk. \; P_w \frac{V_s^2}{2} Q\left(\frac{V s k}{\nu} \right) = P_w U_1^2 k \, F_2 \left(\frac{\delta}{k} \right), \qquad \ldots\ldots (4.1)$$

from which

$$U_1/V_s = F_3 \left(\frac{\delta}{k} \right) Q_1 \left(\frac{V s k}{\nu} \right), \qquad \ldots\ldots (4.2)$$

which is easily shown to reduce to

$$U_1/V_s = F_4 \left(\frac{\delta}{k} \right) Q_2 \left(\frac{U_1 k}{\nu} \right) \qquad \ldots\ldots (4.3)$$

Take now U_1 as proportional to the mean velocity $\bar{U}_m$, so that

$$U_1 \propto U\tau_o \log \frac{\text{Const. D}}{y_1}, \qquad \ldots\ldots(4.4)$$

the constant for pipes being 0.113, D being the pipe diameter (WHITE and COLEBROOK 1937-38), and for open channels 0.40, D being the channel depth. Taking further into consideration the simpler form (3.3) of y_1, we get

$$U_1 \propto U\tau_o \log \frac{\text{Const. } \frac{D}{k}}{\phi\ (\delta/k)}. \qquad \ldots\ldots(4.5)$$

Hence (4.3)may simply be put in the form

$$\left.\begin{aligned} U\tau_c/V_s &= F_4\left(\frac{\delta}{k}, \frac{D}{k}\right) \\ U\tau_c/V_s &= F_5\left(\frac{U\tau_c k}{\nu}, \frac{k}{D}\right) \end{aligned}\right\}, \ldots\ldots(4.6)$$

where $U\tau_c$, meaning the *critical* or *threshold* shear velocity, replaces $U\tau_o$.

To express the left-hand side of (4.6) explicitly in terms of the critical shear velocity, we write

$$\left.\begin{aligned} \tau_c/P_wV_s^2 &= F_6\left(\frac{\delta}{k}, \frac{D}{k}\right) \\ \text{or} \quad \tau_c/P_wV_s^2 &= F_7\left(\frac{U\tau_c k}{\nu}, \frac{k}{D}\right) \end{aligned}\right\}. \qquad \ldots\ldots\ldots(4.7)$$

These expressions lead immediately to the further important results

$$U\tau_c/V_s = F_8\left(\frac{V_s k}{\nu}, \frac{k}{D}\right), \qquad \ldots\ldots(4.8)$$

and

$$\tau_c / P_wV_s^2 = F_9\left(\frac{V_s k}{\nu}, \frac{k}{D}\right). \qquad \ldots\ldots(4.9)$$

After this it only remains to ascertain if theory agrees with experience.

5. Critical Shear Stress Functions in Experience

Figures 3 and 4 show the experimental results for a number of cases, which are of just the nature the theory requires. In fig. 3, $\tau_c/P_wV_s^2$ is plotted against $U\tau_c k/\nu$, whereas in fig. 4, $\tau_c/P_wV_s^2$ is plotted against $V_s k/\nu$. Some six independent sources are represented; namely, H. J. CASEY (1935), G. K. GILBERT (1914), P. Y. HO (1939), H. KRAMER (1932), P. SRICHAMARA (1938) and the U. S. WATERWAYS EXPERIMENT STATION (1935). These experiments were performed with uniform grains of both sand and coal and mixtures of sand, the mean grain diameter ranging from 0.175 mm. to 6.42 mm.

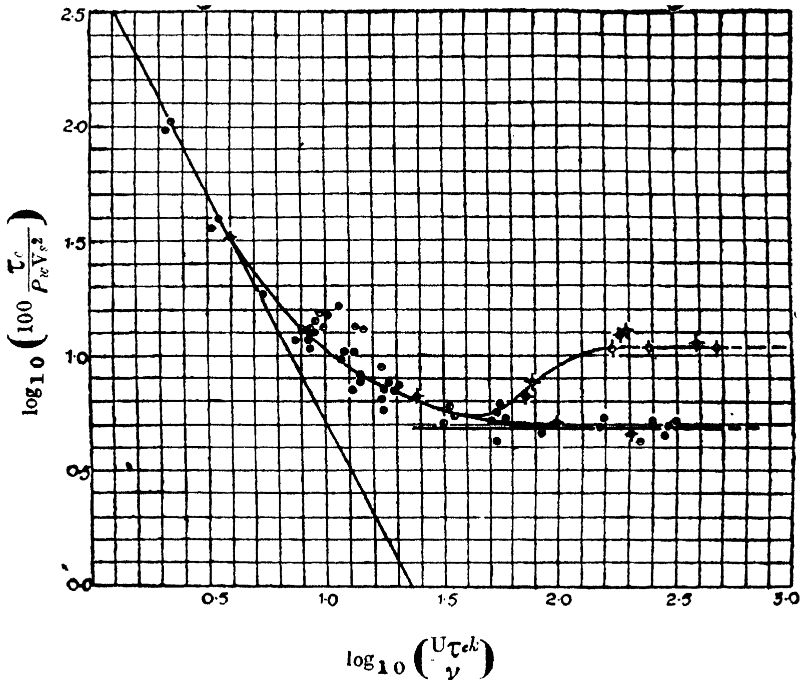


Fig. 3—The Analysis of the Observed Shear Stresses at General Motion Curves Showing $\tau_c/\rho_w V_s^2$ as a Function of $U\tau_c k/\nu$

Observations of H. J. CASEY with uniform grains ⊙ ; of H. J. CASEY with mixtures ◐ ; of G. K. GILBERT with uniform grains ⊕ ; of P. Y. HO with slaty mixture -◇- ; of H. KRAMER with mixtures ● ; of P. SRICHAMARA with uniform grains ◆ ; of the UNITED STATES WATERWAYS EXPERIMENT STATION with mixtures ●.

In the case of mixtures, by mean grain diameter, is meant the size corresponding to the mean value of the abscissæ when the grai nsizes are plotted as abscissæ and the cumulative percentages as ordinates.

Some 105 points are involved, although because of overlapping, they appear fewer in the diagrams. They exhibit a very satisfactory unity, the points grouping into a thin belt, which is inevitable because of the difference in the judgment of the different observers as to the stage of motion, the variety of apparatus, the lack of full information regarding the size, shape and terminal velocity of the particles, and possibly because of the experimental discrepancies. Having regard to all these varying factors, the curves about which the plotted points are seen to lie very close, may be said to well represent the experimental data. As such we may be said to have succeeded in generalizing this mass of varied data in a simple and comprehensive proposition. *This proposition states that at general motion the pure number $\tau_c/\rho_w V_s^2$ is a function of either $U\tau_c k/\nu$ or $V_s k/\nu$.*

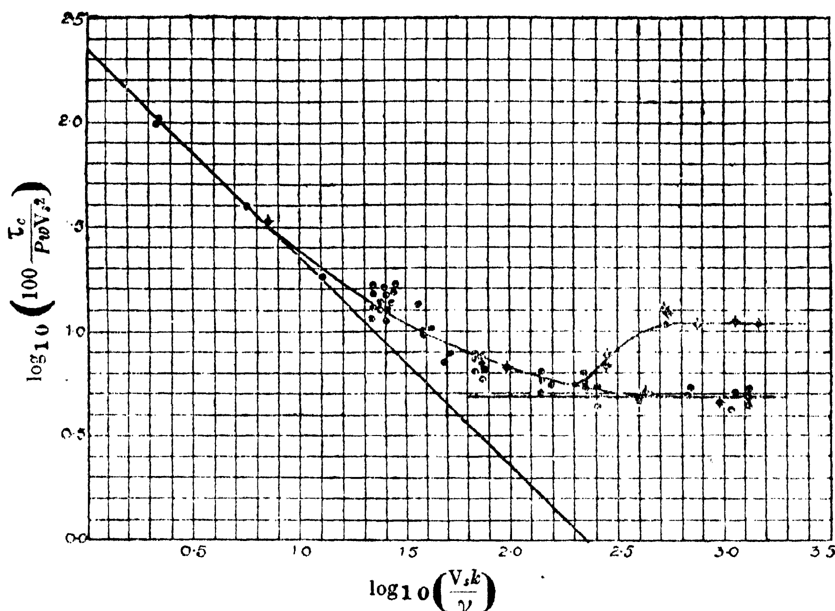


Fig. 4—The Analysis of the Observed Critical Shear Stresses at General Motion Curves showing $\tau_c/P_w V_s^2$ as a Function of $V_s k/\gamma$

Observations of H. J. CASEY with uniform grains ⊙ ; of H. J. CASEY with mixtures ◐ ; of G. K. GILBERT with uniform grains ⊕; of P. Y. HO with slaty mixtures ; of H. KRAMER with mixtures ◐ ; of P. SRICHAMARA with uniform grains ; of the UNITED STATES WATERWAYS EXPERIMENT STATION with mixtures .

6. Discussion of the Critical Shear Stress Curves

On inspection of the two curves in figures 3 and 4, it is seen that they possess certain characteristics. These we briefly state and interpret.

In the first place we could represent either of the two curves by an exponential equation. Thus we may write

$$\tau_c/P_w V_s^2 = \frac{a_1}{100}\left(\frac{U\tau_c k}{\gamma}\right)^{n-2}, \quad \ldots\ldots(6.1)$$

where a_1 is a constant and n varies from 0 to 2 : the value 0 gives the straight line on the left, with a negative slipe of 2:1, which corresponds to laminar flow, and the value 2 gives the horizontal lines parallel to the x-axis on the right, which correspond to the fully turbulent flow. In the latter case, the shear stress τ_c becomes independent of the viscosity effect and is mostly governed by the fluid inertia.

Similarly the curve in fig. 4 can be represented by the exponential equation

$$\tau_c/P_w V_s^2 = \frac{a_2}{100}\left(\frac{V_s k}{\nu}\right)^{n-2}, \quad \ldots\ldots(6.2)$$

where α_2 is a constant and n varies from 1 to 2. The value 1 gives the straight line on the left, dipping at 45° and corresponding to laminar flow, whereas the value 2 corresponds to the fully turbulent flow which is characterized by the curves becoming parallel to the x-axis. Here τ_c is independent of the Reynolds Number $V_s k/\nu$.

Such points of similarity between the two could be multiplied, so that in any further discussion it is only necessary to confine to one of the curves, identical statements being true of the remaining case. So we confine to fig. 3.

In this figure, for values of $U\tau_c k/\nu \leqslant 4.00$, the points lie along a straight line with a slope $-2:1$, corresponding to $n=o$ in equation (6.1), and with the characteristics of the customary pipe resistance or sphere resistance diagrams, the average value of the constant in (6.1) being

$$\alpha_1 = 5.06 \times 10^2. \qquad \ldots\ldots (6.3)$$

So, for $U\tau_c k/\nu \leqslant 4.00$, we have the relation

$$\tau_c / \rho_w V_s^2 = 5.06 \left(\frac{U\tau_c k}{\nu} \right)^{-2} \qquad \ldots\ldots (6.4)$$

In this region, the flow pattern is the same as obtaining when Stokes law of motion around small spheres holds. The inertia forces are negligible in comparison with the viscous effects—viscosity mainly governs the type of flow. The motion is laminar, the resistance and momentum transport arise out of the tangential shear stresses which are proportional to the first power of the velocity. The protuberances remain submerged under the laminar layer and contribute little to the flow pattern.

As the ratio of the inertia forces to viscous forces increases, inertia plays increasing part in the shaping of the flow pattern. Diagrammatically the effect is exhibited by the curve assuming curvature. The dynamic effect is the occurrence of separation and the creation of a wake behind the particles. The skin friction is small and the drag is mainly of the form of *form* drag. The resistance arises out of the inequality of the normal pressure forces at the front and the back of the particles—the particles play an increasing role in the shaping of the flow pattern, and so effect momentum transport.

On the other side, where in (6.1) $n=2$, we have for the lower branch of the curve, extending from $U\tau_c/k\nu \cong 100.00$ to $U\tau_c/k\nu \cong 305.00$,

$$\tau_c = 0.0484 \rho_w V_s^2. \qquad \ldots\ldots (6.5)$$

The upper branch departs from that for the approximately spherical particles at $U\tau_c k/\nu \cong 44.70$. The separation indicates that at high Reynolds Numbers (the case of low Reynolds Numbers being uninvestigated) the influence of the body shape on the drag is very marked. In this case for $172.00 \leqslant U\tau_c k/\nu \leqslant 467.00$, we have

$$\tau_c = 0.1089 \rho_w V_s^2 \qquad \ldots\ldots\ldots (6.6)$$

So the change in the shape has caused the drag co-efficient to finally rise to 2.25 times the value it has when the particles are nearly spherical.

In these ranges, the critical drag becomes proportional to the second power of the terminal velocity and the inertia of the fluid mostly controls the transport mechanism—the size and shape of the particles appear to mainly determine the flow pattern. Instead of viscous mixing, there is mechanical mixing due to turbulence, which penetrates very nearly down to the base of the grains. There is more thorough mixing of the water masses. Consequently, the separation which at low Reynolds Numbers gives rise to regular vortices is considerably delayed or even eliminated. The form resistance as well as the momentum transport attain a constant value.

For Reynolds Numbers between these two respective ranges, there are transition regions, the flow phenomena being influenced by both the viscosity and inertia of the fluid. Here the rate of decrease of n in (6.1) is sufficiently rapid not to warrant any exponential relations of the type of (6.4), (6.5) and (6.6) respectively. Here it is advisable to break up the region into a number of regions and then build up logarithmic formulæ, connecting $\tau_c / \rho_w V_s{}^2$ with $U\tau_c k/\nu$ (with $V_s k/\nu$ in the case of fig. 4), or to solve any practical problem by making use of the appropriate diagram.

7. Acknowledgments

I am greatly indebted to the University of Bombay for the grant of a scholarship which enabled me to carry out this work, which is based upon one of the chapters of a dissertation approved for the Degree of Ph. D. (Engineering) in the University of London. I am also grateful to Asstt. Prof. C. M. White of the Imperial College of Science and Technology, London, for the interest shown in the work.

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Bakhtiarpur,
P.O. Arazi (Dist. Dadu, Sind)

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THE PHOTO-REDUCTION OF FERRIC CHLORIDE IN AQUEOUS SOLUTIONS

In Presence of Organic Acids and Sugars

By

P. R. BAVDEKAR

THE photo-reduction of ferric chloride in presence of organic acids was first observed by Eder (1). Jodin (2) found that the sensitiveness of the reaction in ferric chloride and oxalic acid system increases with dilution though not strictly proportionally. Lemoine (3) showed that the amount of reaction is directly proportional while Kornfeld and Mencke (4) found it to be proportional to the square root of the intensity of light. These results were contradicted by Allmand and Young (5) and Kornfeld (6).

Winther and Oxolt-Howe (7) found that the photo-reduction of ferric chloride in presence of equimolecular quantities of ammonium salts of organic acids is a zeromolecular reaction, and the quantum efficiency is greater than one. Ross (8) found that the photo-reduction of ferric chloride in presence of sugars is also a zeromolecular reaction. But the analytical method employed by them to estimate the amount of reaction (permanganate method) has since been shown to be inaccurate and open to serious objections by Allmand and Young(5).

Ghosh and Purkayastha (9) and later on Purkayastha (10) studied the reduction of ferric chloride in ultra-violet light in presence of organic acids and sugars. Employing a fairly reliable analytical method they also found that the reaction is zeromolecular. It was also found by them that the velocity is independent of temperature and directly proportional to the energy absorbed by the reacting mixture, and also that the quantum efficiency increases with the frequency of the exciting radiations and is less than unity.

Talpade (11) has critically examined the merits of the several methods used to estimate small quantities of ferrous iron in presence of organic substances and large amounts of ferric iron and has come to the conclusion that ceric sulphate is the only titrating agent which can be best employed for this purpose. The present investigation was undertaken mainly with a view to establish the kinetics of the reaction when the ceric sulphate method is employed to determine the amount of reduction from time to time.

EXPERIMENTAL

The source of light used was a Phillip's 1000-watt vertical type cinema projector worked at a constant current of 4.2 amps. The reaction cell was made of optically plane parallel quartz plates; its capacity was 4.5 c.c. and internal thickness 5 mm. It was cemented at the top to a thick glass plate with two holes through which passed two siphon tubes ground to the holes in the plate. To the siphon tubes were attached pieces of India rubber tubing, which were closed air-tight.

The light filters were all Kodak's Wratten filters. The mean wave-length transmitted in each case was determined spectroscopically and was found to be as follows :

Blue filter	4725 A. U.
Yellow filter	5975 A. U.
Red filter	6625 A. U.

The parallel beam of light, after cutting off the heat radiations, fell on the reaction cell which was placed near the window of an electrically heated air thermostat, and was carefully screened from the radiations of the heater. A Hilger thermopile connected to a Moll galvanometer, was placed behind the reaction cell to record the intensity of the incident as well as the emergent light.

Ferric chloride used was of A. R. quality from B. D. H. It was found necessary to add a certain amount of HCl to the aqueous solution in order to prevent the hydrolysis of ferric chloride (9), and stabilise the pH. The solution was stocked for some time before use to obviate the ageing effect. The organic acids and sugars were of Merck's extra pure quality and were used without further purification. These were dissolved in redistilled water and the solutions stocked in air-tight bottles.

In order to measure the absorbed energy the galvanometer deflections were calibrated in terms of Hefner 100 and the energy absorbed was calculated from the deflection differences for the solutions with and without ferric chloride. It was found that the incident energy remained constant throughout all experiments.

After isolating the solution, the cell was taken out and connected to a titration bottle and a wash bottle. When the former was exhausted by a water pump, the water from the wash bottle passed through the reaction cell to the titration bottle, thus draining the cell completely of its contents. The amount of reduction was determined by titrating the solution against a standard solution of ceric sulphate, using diphenylamine as an internal indicator in presence of a few c.c. of syrupy phosphoric acid.

The results obtained are given in the following tables in which the following notations are employed :

a=the initial concentration of ferric chloride expressed in millimoles in 4 c.c. of the reaction mixture,

b=the initial concentration of the organic compounds,

T=the temperature of the thermostat in degrees centigrade,

I=the intensity of the incident light in terms of galvanometer deflections,

λ=the wave-length of the exciting radiations in A. U.,

x=the amount of reduction in millimoles in 4 c.c. of the reaction mixture,

t=the time of exposure in minutes,

K=the velocity constant.

TABLE I

Ferric Chloride and Oxalic Acid

b=0.100 ; T=35°

t	a=1.403		a=0.733		a=0.412	
	X ×10²	K ×10⁴	X ×10²	K ×10⁴	X ×10²	K ×10⁴
30	1.04	3.45	1.04	3.45	0.99	3.30
60	2.02	3.38	2.07	3.45	2.02	3.38
90	3.06	3.40	3.06	3.40	3.02	3.35
120	4.10	3.41	4.05	3.38	4.05	3.38
180	6.12	3.40	6.08	3.38	6.08	3.38
240	8.14	3.39	8.10	3.38	8.14	3.39
300	10.12	3.38	10.08	3.36	10.17	3.39
	Mean	3.40		3.40		3.37

TABLE II

Ferric Chloride and Citric Acid

$b=0.100$; $T=35°$

t	$a=1.403$		$a=0.733$		$a=0.412$	
	$X \times 10^2$	$K \times 10^4$	$X \times 10^2$	$K \times 10^4$	$X \times 10^2$	$K \times 10^4$
30	0.58	1.95	0.58	1.95	0.63	2.10
60	1.17	1.95	1.12	1.88	1.22	2.02
90	1.80	2.00	1.76	1.95	1.80	2.00
120	2.34	1.95	2.34	1.95	2.38	1.99
180	3.46	1.92	3.51	1.95	3.51	1.95
240	4.64	1.93	4.68	1.95	4.64	1.93
300	5.80	1.94	5.85	1.95	5.85	1.95
360	6.98	1.94	6.98	1.94	7.02	1.95

TABLE III

Ferric Chloride and Tartaric Acid

$b=0.100$; $T=35°$

t	$a=1.403$		$a=0.733$		$a=0.412$	
	$X \times 10^3$	$K \times 10^4$	$X \times 10^2$	$K \times 10^4$	$X \times 10^2$	$K \times 10^4$
30	0.54	1.80	0.50	1.65	0.54	1.80
60	1.04	1.72	1.04	1.72	1.08	1.80
90	1.53	1.70	1.58	1.75	1.58	1.75
120	2.02	1.69	2.07	1.72	2.07	1.72
180	3.06	1.70	3.10	1.72	3.06	1.70
240	4.10	1.71	4.14	1.72	4.05	1.69
300	5.13	1.71	5.18	1.72	5.13	1.71
360	6.16	1.71	6.16	1.71	6.21	1.72

TABLE IV

Ferric Chloride and Glucose

$b=0.2651$; $T=35°$

t	$a=0.96$		$a=0.48$		$a=0.24$	
	$X \times 10^3$	$K \times 10^5$	$X \times 10^3$	$K \times 10^5$	$X \times 10^3$	$K \times 10^5$
60	2.79	4.650	2.79	4.650	2.75	4.583
120	5.62	4.683	5.62	4.683	5.45	4.542
180	8.46	4.700	8.42	4.678	8.19	4.550
240	11.30	4.708	11.16	4.650	10.94	4.558
300	14.08	4.693	13.90	4.633	13.64	4.547
360	16.83	4.675	16.70	4.639	16.38	4.550
480	22.41	4.669	22.23	4.631	21.87	4.558
600	27.90	4.650	27.81	4.635	27.36	4.560

TABLE V

Ferric Chloride and Sucrose

$b=0.2805$; $T=35°$

t	$a=0.96$		$a=0.48$		$a=0.24$	
	$X \times 10^3$	$K \times 10^5$	$X \times 10^3$	$K \times 10^5$	$X \times 10^3$	$K \times 10^5$
60	2.30	3.833	2.25	3.750	2.20	3.667
120	4.59	3.825	4.50	3.750	4.46	3.717
180	6.84	3.800	6.66	3.700	6.66	3.700
240	9.00	3.750	8.91	3.712	8.86	3.692
300	11.30	3.765	11.30	3.765	11.12	3.707
360	13.54	3.762	13.50	3.750	13.32	3.700
480	18.14	3.778	18.14	3.778	17.82	3.712
600	22.64	3.773	22.55	3.758	22.32	3.720

TABLE VI

Ferric Chloride and Laevulose

$b=0.3350$; $T=35°$

t	$a=0.96$		$a=0.48$		$a=0.24$	
	$X \times 10^3$	$K \times 10^5$	$X \times 10^3$	$K \times 10^5$	$X \times 10^3$	$K \times 10^5$
60	2.16	3.600	2.16	3.600	2.12	3.533
120	4.36	3.633	4.36	3.633	4.28	3.567
180	6.57	3.650	6.52	3.622	6.44	3.578
240	8.78	3.678	8.68	3.617	8.55	3.562
300	10.89	3.630	10.80	3.600	10.75	3.583
360	13.05	3.625	12.92	3.589	12.92	3.589
480	17.28	3.600	17.23	3.590	17.19	3.581
600	21.51	3.585	21.51	3.585	21.46	3.577

From the above tables it will be clearly seen that the order of the photo-reduction of ferric chloride in presence of organic acids (oxalic, citric and tartaric) and sugars (glucose, sucrose and laevulose) is a zeromolecular reaction. Straight lines are obtained when the amount of reduction is plotted against the time of isolation. Also the values of the velocity (x/t) or velocity constant are constant within limits of experimental error and are not appreciably affected by a change in the initial concentration of ferric chloride. This can be seen from the following table in which the values of K are the mean values :

TABLE VII

Organic Substance	$K \times 10^4$ for		
	$a=1.403$	0.733	0.412
Oxalic Acid	3.40	3.40	3.37
Citric Acid	1.95	1.94	1.99
Tartaric Acid	1.72	1.71	1.74
	$a=0.96$	0.48	0.24
Glucose	0.468	0.465	0.456
Sucrose	0.379	0.374	0.370
Laevulose	0.362	0.360	0.357

This conclusion regarding the order of the reaction is in agreement with that arrived at by other workers (*cf.* Winther and Oxolt-Howe (7), Ghosh and Purkayastha (9), Allmand and Young (5), and Kornfeld (6) in case of acids, and Purkayastha (10) and Ross (8) in case of sugars), who studied these reactions in radiations other than those used in the present investigation and employed different methods for the estimation of the amount of reduction.

The Effect of Temperature

The effect of temperature was examined by studying the kinetics of the reaction at 30° and 40° in composite light. The results obtained are given in the following tables in which X_1 and X_2 denote $X \times 10^3$ at 30° and 40°, respectively :

Table VIII

Ferric Chloride and Oxalic Acid

t	a=1.403		a=0.733		a=0.412	
	X_1	X_2	X_1	X_2	X_1	X_2
60	18.4	23.4	18.4	23.8	18.4	23.4
120	37.4	46.4	36.9	47.2	37.4	46.8
240	74.2	93.6	73.4	94.0	74.2	94.0
360	110.7	140.8	110.2	141.3	111.2	140.8

Table IX

Ferric Chloride and Citric Acid

t	a=1.403		a=0.733		a=0.412	
	X_1	X_2	X_1	X_2	X_1	X_2
60	10.8	14.0	10.8	13.5	10.4	13.5
120	21.2	27.4	21.6	26.6	21.2	27.0
240	42.3	54.4	42.8	53.6	41.8	54.4
360	63.4	81.4	63.9	81.0	63.4	81.0

Table X

Ferric Chloride and Tartaric Acid

t	a=1.403		a=0.733		a=0.412	
	X_1	X_2	X_1	X_2	X_1	X_2
60	9.4	12.2	9.4	12.6	9.9	12.2
120	18.9	23.8	19.4	24.3	19.4	24.3
240	37.4	47.7	37.8	48.6	38.2	48.2
360	56.7	72.0	56.7	72.4	57.2	72.0

TABLE XI

Ferric Chloride and Sucrose

t	a=0.96		a=0.48		a=0.24	
	X_1	X_2	X_1	X_2	X_1	X_2
60	2.16	2.52	2.16	2.43	2.16	2.52
120	4.23	4.95	4.32	4.95	4.23	5.04
240	6.48	7.38	6.39	7.38	6.39	7.47
360	8.64	9.90	8.64	9.81	8.55	9.90

TABLE XII

Ferric Chloride and Glucose

t	a=0.96		a=0.48		a=0.24	
	X_1	X_2	X_1	X_2	X_1	X_2
60	2.70	3.24	2.79	3.33	2.70	3.24
120	5.31	6.39	5.44	6.57	5.44	6.39
240	8.01	9.72	8.19	9.72	8.10	9.63
360	10.71	12.96	10.89	12.96	10.80	12.87

TABLE XIII

Ferric Chloride and Laevulose

t	a=0.96		a=0.48		a=0.24	
	X_1	X_2	X	X_2	X_1	X_2
60	1.98	2.43	2.07	2.43	2.07	2.52
120	4.05	4.86	4.14	4.86	4.05	4.95
240	6.03	7.38	6.21	7.29	6.12	7.38
360	8.01	9.72	8.19	9.72	8.10	9.81

The values of the mean velocity constants calculated from the data given in tables VIII-XIII are given in the following tables :

TABLE XIV

	$K \times 10^4$ for					
	a=1.403		a=0.733		a=0.412	
	30°	40°	30°	40°	30°	40°
Oxalic Acid	3.09	3.89	3.06	3.94	3.09	3.91
Citric Acid	1.77	2.39	1.79	2.24	1.75	2.25
Tartaric Acid	1.57	2.00	1.58	2.04	1.61	2.01

TABLE XV

	K×10⁴ for					
	a=0.96		a=0.48		a=0.24	
	30°	40°	30°	40°	30°	40°
Glucose	0.452	0.536	0.458	0.546	0.446	0.538
Sucrose	0.356	0.417	0.359	0.409	0.358	0.414
Laevulose	0.334	0.406	0.344	0.405	0.340	0.413

The values of temperature coefficients for a ten degree rise ($K_{40°}/K_{30°}$) are given in the following table:

TABLE XVI

	a=1.403	a=0.733	a=0.412	Mean
Oxalic Acid	1.261	1.284	1.264	1.270
Citric Acid	1.290	1.250	1.289	1.276
Tartaric Acid	1.273	1.288	1.250	1.270
	a=0.96	a=0.48	a=0.24	Mean
Glucose	1.207	1.192	1.185	1.195
Sucrose	1.172	1.140	1.155	1.155
Laevulose	1.215	1.177	1.214	1.202

It will be seen from the above table that the values obtained for the temperature coefficients of the photo-reduction of ferric chloride in presence of the three acids as well as the three sugars are almost of the same magnitude and are very nearly unity. This shows that these reactions may be said to be ideally photochemical.

THE EFFECT OF WAVE-LENGTH

The effect of different wave-lengths was studied by studying the kinetics of the reaction in radiations filtered through the three filters described before. The results obtained are given in the following tables in which X_b, X_y and X_r denote $X \times 10^2$ in blue, yellow and red light, respectively:

TABLE XVII

a=0.987 ; b=0.100 ; T=35°

t	Oxalic acid			Citric acid			Tartaric acid		
	X_b	X_y	X_r	X_b	X_y	X_r	X_b	X_y	X_r
60	2.43	2.02	1.62	1.40	1.12	0.94	1.22	0.99	0.81
120	4.86	4.00	3.20	2.84	2.25	1.94	2.43	1.94	1.62
180	7.24	6.03	4.77	4.23	3.33	2.88	3.64	2.92	2.38
240	9.72	8.06	6.39	5.58	4.46	3.82	4.86	3.92	3.24

TABLE XVIII

a=0.987 ; b=3622 ; T=35°

t	Oxalic acid			Citric acid			Tartaric acid		
	X_b	X_y	X_r	X_b	X_y	X_r	X_b	X_y	X_r
60	0.33	0.28	0.22	0.27	0.22	0.18	0.26	0.22	0.17
120	0.66	0.56	0.44	0.54	0.45	0.37	0.51	0.43	0.35
180	0.99	0.84	0.67	0.80	0.67	0.54	0.77	0.64	0.52
240	1.32	1.11	0.89	1.08	0.89	0.71	1.04	0.86	0.69

It will be seen from the above two tables that the reaction takes place the most in blue light and the least in red, that is, the rate of reaction increases as the frequency of the radiations is increased. These results are in accordance with the expectations since the total energy of the absorbed light increases with the increase in the frequency of the exiciting radiations.

The Effect of Intensity

The effect of the intensity of the incident light was examined by studying the reaction for one hour in composite light at 35°. The changes in the incident intensity were effected by changing the distance of the source of light from the reaction cell, thereby causing no change in the quality of light. The results obtained are given below :

Table XIX

$a=0.972$; $b=0.100$; $T=35°$

I_0	Oxalic acid		Citric acid		Tartaric acid	
	$X \times 10^3$	$K \times 10^4$	$X \times 10^3$	$K \times 10^4$	$X \times 10^3$	$K \times 10^4$
25.00	21.60	3.600	12.60	2.100	11.25	1.875
21.15	18.45	3.075	10.80	1.800	9.45	1.575
14.45	12.60	2.100	7.20	1.200	6.75	1.125

Table XX

$a=0.9720$; $b=0.3622$; $T=35°$

I_0	Glucose		Sucrose		Laevulose	
	$X \times 10^3$	$K \times 10^5$	$X \times 10^3$	$K \times 10^5$	$K \times 10^3$	$K \times 10^5$
25.00	3.24	5.40	2.52	4.20	2.52	4.20
21.15	2.70	4.50	2.16	3.60	2.07	3.45
14.45	1.89	3.15	1.44	2.40	1.44	2.40

It will be seen that the effect of the intensity of the incident light is quite marked. the amount of reduction is decreased on decreasing the intensity of light. The following table gives the ratios of the velocity constants and the corresponding ratios of the intensities, in which I_1, I_2 and I_3 are the intensities and K_1, K_2 and K_3, the corresponding values of the velocity constants :

Table XXI

	Organic acids			Sugars		
	Oxalic	Citric	Tartaric	Glucose	Sucrose	Laevulose
$I_2/I_1 = 1.46$ $K_2/K_1 =$	1.46	1.50	1.40	1.43	1.50	1.44
$I_3/I_2 = 1.18$ $K_3/K_2 =$	1.17	1.17	1.19	1.20	1.17	1.22
$I_3/I_1 = 1.73$ $K_3/K_1 =$	1.71	1.75	1.67	1.71	1.75	1.75

It can be seen from the above table that the rate of reaction is directly proportional to the intensity of the incident light, the slight deviations being within limits of experimental error. These results are in agreement with those obtained by Purkayastha (10) and Allmand and Young (5).

Dhar (*The Chemical Action of Light*) has shown that the amount of radiation absorbed is directly proportional to the incident intensity. Assuming the validity of Dhar's conclusions, these results show that the rate of reaction is directly proportional to the absorbed energy.

Quantum Efficiency Measurements

The quantum efficiency of the reaction for different wave-lengths with different concentrations of ferric chloride was measured by using the same filters as used in the study of the kinetics of the reaction. The time of exposure of the reaction mixtures was one hour in all cases. The number of molecules changed during the period of exposure was calculated from the titration data and the number of quanta absorbed was determined from the measurement of the absorbed energy. The results obtained are given in the following table :

Table XXII

Organic Substance	*a*	Quantum Efficiency at 35° for		
		4725 A. U.	5795 A. U.	6625 A. U.
Oxalic Acid	0.50	0.33	0.26	0.22
	0.10	0.46	0.36	0.30
	0.05	0.48	0.38	0.29
Citric Acid	0.50	0.19	0.16	0.13
	0.10	0.27	0.22	0.18
	0.05	0.27	0.21	0.18
Tartaric Acid	0.50	0.22	0.18	0.14
	0.10	0.29	0.24	0.19
	0.05	0.28	0.24	0.20
Glucose	0.50	0.19	0.16	0.13
	0.10	0.35	0.27	0.23
	0.05	0.36	0.28	0.24
Sucrose	0.50	0.16	0.13	0.11
	0.10	0.28	0.22	0.18
	0.05	0.28	0.23	0.19
Laevulose	0.50	0.18	0.14	0.12
	0.10	0.33	0.26	0.22
	0.05	0.32	0.26	0.22

It will be seen from the above table that the values of the quantum efficiency of the photo-reduction of ferric chloride in presence of organic acids and sugars are low, being in all cases less than unity. Further it will be seen that the effect of decreasing the concentration of ferric chloride from 0.50 to 0.10 is to increase the quantum efficiency, but further decrease in the concentration to 0 05 causes no great change in the quantum efficiency , as a matter of fact it remains constant. This shows that the maximum efficiency value, as far as the concentration of ferric chloride is concerned, is attained at this stage. It may be surmised that the number of col isions between the activated and the unactivated molecules of ferric chloride reach a maximum value at this stage. Also it will be seen that the values of the quantum efficiency decrease as the wave-length of the exciting radiations is increased. It is evident, therefore, that more molecules of ferric chloride are changed for every quantum of light absorbed, in light of a higher frequency than in that of a lower one.

The effect of temperature on the quantum efficiency of the reaction was examined by determining the quantum yields at 30° and 40° in addition to those at 35° The effect was studied only in blue light. The results obtained are given below :

TABLE XXIII

Organic Substance	a	Quantum Efficiency for λ =4725 A.U. at		
		30°	35°	40°
Oxalic acid	0.50	0.28	0.33	0.42
	0.10	0.38	0.46	0.66
	0.05	0.39	0.48	0.69
Citric acid	0.50	0.16	0.19	0.23
	0.10	0.24	0.27	0.41
	0.05	0.23	0.27	0.42
Tartaric acid	0.50	0.20	0.22	0.30
	0.10	0.25	0.29	0.46
	0.05	0.26	0.28	0.47
Glucose	0.50	0.16	0.19	0.28
	0.10	0.28	0.35	0.47
	0.05	0.30	0.36	0.48
Sucrose	0.50	0.14	0.16	0.22
	0.10	0.24	0.28	0.40
	0.05	0.25	0.28	0.42
Laevulose	0.50	0.16	0.18	0.26
	0.10	0.27	0.33	0.48
	0.05	0.28	0.32	0.48

It will be seen that the temperature has a marked effect on the quantum efficiency of the reaction. Also it can be seen that it is more marked for the same rise of temperature at a higher temperature. One is tempted to put forward the analogy between these results and those obtained in case of the effect of temperature on the velocity constant. Such results have been obtained in many cases studied in this laboratory but the only other case reported in the literature is the work of Kuhn (12) who, while studying the photodecomposition of ammonia, obtained a 50 per cent increase in the quantum yield for every 100 degree rise in temperature. He attributed this increase to the change in the kinetics of the reaction at higher temperatures.

The author wishes to thank Dr. Mata Prasad for having suggested this problem and for his keen interest and inspiring guidance throughout the progress of the work.

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THE CHEMICAL LABORATORIES,
THE ROYAL INSTITUTE OF SCIENCE,
BOMBAY

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STUDY OF THE HYDROLYSIS OF CHLORINE

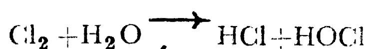
By

G. B. KOLHATKAR AND U. A. SANT

INTRODUCTORY

THE hydrolysis of chlorine is studied by many investigators.* G. Lunge and Shaeppi, Chem. & Ind. *4* [1881] 2193. Jakowkin, Z. Phy. Che. *29* [1899] 616. A Richardson, J. C. S. *83* [1903] 380, Clark and Iseley, J. Ind. & Eng. Chem. *2* [1920] 1119. Benrath and Tuchel, Zeitsch, Wiss. Photochem. *13* [1914] 383-98. Dawson, *Ibid.* *14* [1914] 213-15. Shilov and Kupinskaja, Compt. Rend. Acad. Sci., U. R. S. S. *2* [1935] 222-24. Shilov and Solodushenkovi, *Ibid.* *3* [1936] 15-19.

Chlorine reacts with water as follows :—



$$Cl_2 + H_2O \rightleftharpoons HCl + HOCl$$

To allow equilibrium to be established between chlorine, hydrochloric acid and hypochlorous acid, in chlorine water, Jakowkin proceeds to determine the hydrolysis of chlorine, a few hours after preparing chlorine water. Shilov and his co-workers, however, find that the hydrolysis of chlorine is very rapid even at a temperature as low as 1.2°C. Equilibrium is established in less than two minutes. Present investigation confirms the view of Shilov and his co-workers and shows that chlorine water is immediately formed, if equivalent amounts of hydrochloric and hypochlorous acid are mixed together.

EXPERIMENTAL

To study the hydrolysis of chlorine, it is necessary to estimate the proportion of free chlorine, hydrochloric acid and hypochlorous acid in chlorine water. Chemical methods are not suited as they remove one of the products and thus disturb the equilibrium.

As is done by Jakowkin, Benrath and Tuchel and Shilov and his co-workers, conductivity method is, therefore, used for the purpose.

CONDUCTIVITY METHOD

Conductivity of chlorine water is due to the hydrochloric acid present in it, since free chlorine does not impart to chlorine water any conductivity and the conductivity due to hypochlorous acid is very small and in comparison with that imparted by hydrochloric acid, may be neglected.

* See Gmelin's Handbook Der Anorganischen Chemie, 8 Auflage Chlor, system number 6, pages 64, 65, 66, 295 and 296.

Pure chlorine is prepared by allowing concentrated hydrochloric acid to fall drop by drop on crystals of potassium permanganate. It is bubbled through a little cold water to remove hydrochloric acid and then collected in a bottle (capacity about 3 litres). About 500 c.c. of water are added to the bottle and the chlorine and water are shaken together for one minute. A conductivity cell is then filled with the chlorine water thus prepared and its conductivity is immediately determined. To prevent the action of light on chlorine water, the cell and the bottle are covered with a black paper. The total time spent in (i) adding water to chlorine, (ii) transferring the chlorine water to the conductivity cell, and (iii) determination of the conductivity, is not more than a few minutes. The conductivity is determined again after three hours. Concentration of chlorine in chlorine water is estimated by potassium iodide and sodium thiosulphate. The results obtained are given below in a tabular form :—

TABLE I

Temperature 25°C.

Strength of chlorine water in normal terms	Dilution (number of litres containing a mol. of chlorine)	Value of the molecular conductivity determined immediately	*Value of the molecular conductivity determined after three hours
N/11	22	197.7	196
N/23.5	47	278.5	280
N/46.5	93	343	344

The values of the conductivity when determined immediately and when determined after three hours are the same. The equilibrium between free chlorine, hydrochloric acid and hypochlorous acid in chlorine water is thus established rapidly.

Chlorine water is immediately formed by mixing together equivalent amounts of hydrochloric acid and hypochlorous acid.

Pure hypochlorous acid is prepared by passing chlorine in a litre of water in which is suspended about 40 gms. of freshly precipitated mercury oxide. The mixture of HOCl and $HgCl_2$ so formed, is then distilled. The middle portion of the distillate is collected as pure hypochlorous and absence of chlorine in the hypochlorous acid, so prepared, is shown by bubbling through it a current of air and then passing the air, so bubbled, through a solution of potassium iodide. The faint yellow colour due to the liberated iodine disappears on adding only a drop of N/50 sodium thiosulphate solution. The conductivity of the solution of hypochlorous acid is then determined. It is very small, showing the absence in it of hydrochloric acid. The strength of hypochlorous acid is determined by adding to it potassium iodide, a little pure acetic acid and titrating it with a solution of sodium thiosulphate.

Equal volumes of the solutions of N/20 hydrochloric acid and N/10 hypochlorous acid are mixed. Even with careful mixing, loss of a little chlorine cannot be avoided. The mixture is transferred to the conductivity cell. The conductivity of the mixture is determined (i) immediately and (ii) after three hours. The amount of chlorine present

*Jakowkin obtained 200.2, 270, 338 as values of the molecular conductivity of chlorine water at dilutions 22.96, 45.2, and 91.34 litres respectively. The values of the conductivities obtained by him are approximately the same as those obtained above.

in the mixture is determined by potassium iodide (acidified with dilute acetic acid) and sodium thiosulphate. Solutions of N/20 hypochlorous acid and N/40 hydrochloric acid are also mixed, and the conductivity of the mixture is determined in a similar way. The results of the conductivity measurements are given below :—

TABLE II

A..... Mixture of N/10 HOCl and N/20 HCl

B..... Mixture of N/20 HOCl and N/40 HCl

Temperature 25° C.

Strength in normal terms	Dilution (number of litres containing a mol. of chlorine)	*Value of the molecular conductivity immediately determined	Value of the molecular conductivity determined after three hours
A . . N/23.5	47	278.0	280.0
B . . N/46.5	93	343.5	344.0

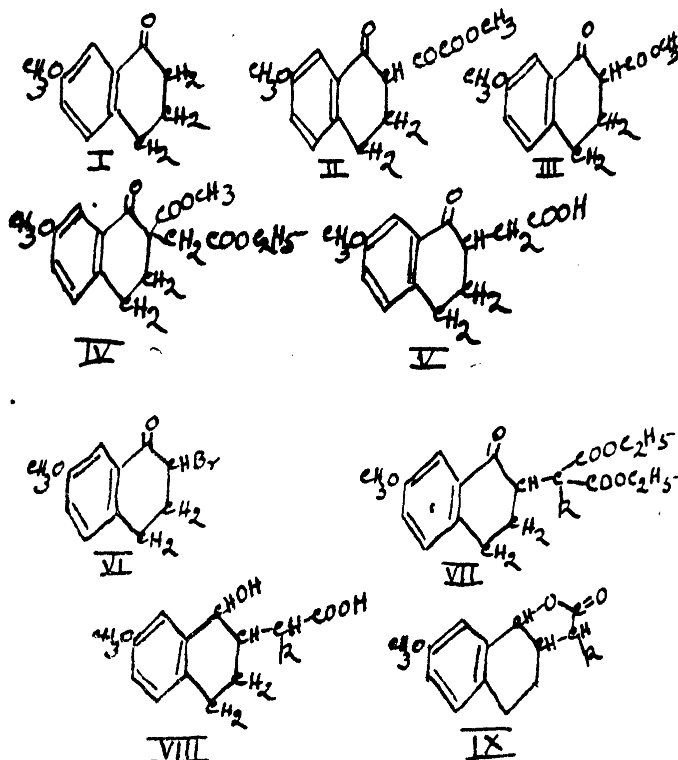
CONCLUSION

The views of Shilov and his co-workers that the hydrolysis of chlorine is a very rapid reaction is confirmed and it is shown that chlorine water is immediately formed by mixing together equivalent amounts of hydrochloric acid and hypochlorous acid.

FERGUSSON COLLEGE,
POONA

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*By comparing the results given in Table I with those in Table II, it will be seen that the conductivities of chlorine water of the same strength, whether prepared by dissolving chlorine in water or mixing HCl and HOCl, are the same.



EXPERIMENTAL

Methyl-1-keto-7-methoxy-1-2-3-4-tetrahydro napthyl-2-glyoxalate:—1-keto-7-methoxy 1-2-3-4-tetrahydro naphthalene (8.8 gms) were mixed with dimethyl oxalate (5.8 gms) and added to sodium methoxide prepared from sodium (1.1 gms) and methyl alcohol (15 cc) with proper cooling. An orange yellow sodium salt separated after some time. It was left overnight and decomposed with ice and dilute sulphuric acid, extracted with ether, dried and ether removed. It was soluble in methyl and ethyl alcohol acetone and sparingly soluble in petrol and hexane. It crystallised in reddish yellow oblong octahedral prisms m.p. 57°. It gave red colouration with ferric chloride and formed a semicarbazone m.p. 225°. (Found: C, 63.8 ;H, 5.3 per cent. $C_{14}H_{14}O_5$ requires C, 64.1; H, 5.3 per cent.)

Methyl-1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene-2-carboxylate :—The above glyoxalate was heated first at 150 and then at 180° for one hour and then distilled under reduced pressure. b.p 205° at 70 mm. It immediately solidified to fanlike colourless needles m.p. 57.5 and depressed the m.p. of the glyoxalate. It gave a violet colouration with ferric chloride. (Found: C, 66.5 ; H, 5.9 per cent. $C_{13}H_{14}O_4$ requires C, 66.7; H, 6.0 per cent.)

Methyl ethyl 1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene-2-carboxylate-2-acetate :—It was obtained by treating the sodio derivative of the above ester with ethyl bromoacetate. It crystallised from dilute alcohol in cubes m.p. 61°. (Found: C, 63.9 ; H, 6.4 per cent. $C_{17}H_{20}O_6$ requires C, 63.8 ; H, 6.3 per cent.)

The above ester could not be hydrolysed under any conditions.

1-keto-7-methoxy-2-bromo-1-2-3-4-tetrahydro naphthalene :—1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene (8.8 gms) was dissolved in carbon disulphide (20 cc) and to this solution was added bromine (8 gms) in carbon disulphide (20 cc.) The solvent was allowed to evaporate at ordinary temperature and the residue crystallised from petrol m.p. 48°. (Found: Br, 31.2 per cent. $C_{11}H_{11}O_2$ Br requires Br, 31.37 per cent.)

1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene-2-acetic acid :—1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene (8.8 gms) sodamide (2 gms) and anhydrous ether (100 cc) were refluxed together for six hours in a current of hydrogen. Ethyl bromoacetate (8.4 gms) were then added and heating continued for four hours longer. Water was then added and the ester recovered by ether extraction was directly hydrolysed by alkali. yield 1.5 gms. It crystallised from chloroform petrol mixture and had m.p. 88. (Found: C, 66, 1 ; H, 6.0 per cent. $C_{13}H_{14}O_4$ requires C, 66.6 ; H, 6.0 per cent.)

Diethyl 1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene-2-malonate :—To sodio derivative of ethyl malonate prepared from ethyl malonate (8 gms) sodium (1.15) gms in benzene (200 cc) was aded 1-keto-2-bromo-7-methoxy-1-2-3-4-tetrahydro naphthalene (12.8 gms) and the whole refluxed for six hours. Dilute hydrochloric acid was then added, benzene layer separated, washed, dried and benzene removed. The crude ester thus obtained was used for reduction and on acid hydrolysis gave 1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene-2-acetic acid m.p. 88° described above.

1-hydroxy-7-methoxy-1-2-3-4-tetrahydro naphthalene-2-acetic acid :—diethyl 1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene-2-malonate (17 gms) dissolved in isopropyl alcohol (33 cc) was added to aluminum isopropoxide prepared from aluminum (1 gms) isopropyl alcohol (33 cc) and mercuric chloride (0.1 gms). It was refluxed for two hours and alcohol was distilled off. The ester recovered from the above was hydrolysed by alcoholic sodium hydroxide. The acid obtained from precipitating the cold alkaline solution by ice cold hydrochloric acid was crystallised from dilute alcohol and had m.p. 88°. (Found: C,66.1; H, 6.8 per cent. Eqt. wt. 235. 9. $C_{13}H_{16}O_4$ requires C, 66.1; H, 6.8 per cent. Eqt. wt. 234.)

Lactone of 1-hydroxy-7-methoxy-1-2-3-4-tetrahydro naphthalene-2-acetic acid :—It was obtained by heating the above acid on water bath for two hours. It was treated with a dilute solution of sodium bicarbonate to remove the acidic impurities. It was soluble in all the common solvents and crystallised from dilute alcohol in needles m.p. 76° (Found: C, 71.4 ; H, 6.5 per cent. Eqt. wt. by back titration, 217.7. $C_{13}H_{14}O_3$ requires C, 71.5 ; H, 6.4 per cent. Eqt. wt. 218.)

Lactone of 1-7-dihydroxy-1-2-3-4-tetrahydro naphthalene-2-acetic acid :—It was obtained by demethylating the above by hydrobromic acid in acetic acid. It was soluble in all the solvents except petrol and hexane. It crystallised from carbon tetrachloride in needles m.p. 101°. (Found : C, 70.5 ; H, 5.9 per cent. Eqt. wt. by back titration, 203.9. $C_{12}H_{12}O_3$ requires C, 70.6 ; H, 5.9 per cent. Eqt. wt. 204.)

Diethyl-1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene-2-methylmalonate :—It was obtained by treating the sodio derivative of diethyl methyl malonate with 1-keto-2-bromo-7-methoxy 1-2-3-4-tetrahydro naphthalene in benzene and working up as described before. The crude ester was used to prepare the following.

1-keto-7-methoxy-1-2-3-4-tetrahydro naphthalene-2- α -propionic acid :—This was obtained by acid hydrolysis of the above ester. It was sparingly soluble in petrol and hexane and freely soluble in other solvents. It crystallised from dilute alcohol in needles m.p. 91°. (Found: C, 67.9 ; H, 6.4 per cent. Eqt. wt. 249.1. $C_{14}H_{16}O_4$ requires C, 67.7 , H, 6.5 per cent. Eqt. wt. 248.)

1-hydroxy-7-methoxy-1-2-3-4-tetrahydro naphthalene-2- α -propionic acid :—It was obtained by the reduction of the corresponding malonic ester by aluminum isopropoxide and working up as described before. It crystallised from dilute alcohol in needles m.p. 77°. (Found: C, 67.3 ; H, 7.2 per cent. Eqt. wt. 251.1. $C_{14}H_{18}O_4$ requires C, 67.2 ; H, 7.2 per cent. Eqt. wt. 250.)

Lactone of 1-hydroxy-7-methoxy-1-2-3-4-tetrahydro naphthalene-2- α -propionic acid :—It was obtained by heating the acid on water bath for two hours. It crystallised from benzenes in cubes m.p. 83°. (Found: C, 72.4 ; H, 6.9 per cent. Eqt. wt. by back titration, 231.8. $C_{14}H_{16}O_3$ requires C, 72.2 ; H, 6.9 per cent. Eqt. wt. 232.)

Lactone of 1-7-dihydroxy-1-2-3-4-tetrahydro naphthalene-2 α -propionic acid:—It was obtained by demethylation of the above. It crystallised from carbon tetrachloride in small prisms m.p. 112°. (Found: C, 71.4 ; H, 6.5. per cent. Eqt. wt. by back titration, 218.1. $C_{13}H_{14}O_3$ requires C, 71.5 ; H, 6.4 per cent. Eqt. wt. 218.)

We thank Professor Bhide, Head of the Chemistry Department, for his keen interest and helpful suggestions.

MAHARAJA PRATAPSINH
CHEMICAL LABORATORIES,
S. P. COLLEGE, POONA

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CONDENSATION OF N-ALKYL SUCCINIC ANHYDRIDES WITH ANISOLE

By

S. U. MEHTA, K. V. BOKIL AND K. S. NARGUND

THE purpose of the present work was to prepare α alkyl r-p-methoxy phenyl butyrolactones with a view to study their anthelmintic action. As a preliminary step in this direction α alklyl β-p-methoxy benzoyl propionic acids have now been prepared by the condensation of n-alkyl succinic anhydrides with anisole by Friedel and Craft's reaction. Although there are two possibilities in the condensation still very often only one type of keto acids are obtained (Compare Bhatt and Nargund, Jour. Bom. Univ., 1942, 11, 131). The constitutions of the keto acids were established by oxidation when anisic acid was obtained. All the keto acids reacted with salicylic aldehyde in presence of dry hydrogen chloride to yield pyrilium derivatives thus indicating the presence of $COCH_2$ grouping in the keto acids. The keto acids were characterised by derivatives such as methyl and ethyl esters and semicarbazones.

EXPERIMENTAL

Methyl, ethyl, n-propyl, and n-hexyl succinic anhydrides were prepared by standard methods. n-Amyl, n-tetradecyl, n-hexadecyl succinic anhydrides were the samples described by Mehta and Nargund. (Jour. Bom. Univ., 1942, *10*, 141; *ibid*, 1942, *11*, 134.) General procedure for the condensation of n-alkyl succinic anhydrides with anisole :—To a mixture of n-alkyl succinic anhydride (0.1 mol) nitrobenzene (75 gms) and anisole (11 gms) was gradually added anhydrous aluminum chloride (28 gms) taking care that the temperature did not go beyond 40°. It was then kept at room temperature for four hours, decomposed with ice and dilute hydrochloric acid and steam distilled to remove nitrobenzene. It was then dissolved in sodium carbonate solution, boiled with addition of animal charcoal, filtered and acidified. The solid thus obtained was crystallised from a suitable solvent. The yields of the pure keto acids obtained by the above procedure are given in the following table:—

TABLE

Alkyl succinic anhydride used	Keto acid obtained	Yield per cent
Methyl succinic anhydride ..	α Methyl-β-p-methoxy benzoyl propionic acid.	50
Ethyl succinic anhydride	α ethyl-β-p-methoxy benzoyl propionic acid	70
n-propyl succinic anhydride	α n-propyl-β-p-methoxy benzoyl propionic acid	62
n-amyl succinic anhydride	α n-amyl-β-p-methoxy benzoyl propionic acid	30
n-hexyl succinic anhydride	α n-hexyl-β-p-methoxy benzoyl propionic acid	45
n-tetradecyl succinic anhydride ..	α n-tetradecyl-β-p-methoxy benzoyl propionic acid	60
n-hexadecyl succinic anhydride ..	α n-hexadecyl-β-p-methoxy benzoyl propionic acid	50

α Methyl-β-p-methoxy benzoyl propionic acid crystallised from methyl alcohol in needles m.p. 141. Mitter and De (Jour. Ind. Chem. Soc., 1939, 199) give 144° as the m.p. *Methyl α methyl-β-p-methoxy benzoyl propionate* was a colourless liquid. b.p. 173-180 at 18 mm. $D_4^{35.7}=1.128$ and $N_D^{35.7}=1.5245$. (Found : C, 65.9 ; H, 6.9 per cent. $C_{13}H_{16}O_4$ requires C, 66.1 ; H, 6.8 per cent.) *Ethyl α methyl-β-p-methoxy benzoyl propionate* had b.p. 190 at 30 mm. $D_4^{35.7}=1.121$ $N_D^{35.7}=1.5170$ (Found : C, 67.1 ; H, 7.4 per cent. $C_{14}H_{18}O_4$ requires C, 67.2 ; H, 7.2 per cent.)

α Ethyl-β-p-methoxy benzoyl propionic acid :—It was soluble in the common solvents except petrol and crystallised from benzene in plates m.p. 108–109°. (Found. C, 66.0 ; H, 6.8 per cent. Eqt. wt, 237.5 $C_{13}H_{16}O_4$ requires C, 66.1 ; H, 6.8 per cent. Eqt. wt. 236.) It formed a semicarbazone m.p. 155°. (Found : Eqt. wt. 295.2. $C_{14}H_{19}O_4N_3$ requires eqt. wt. 293.) *Methyl α ethyl-β-p-methoxy benzoyl propionate* was a colourless solid soluble in all the common solvents and crystallised from petrol in cubes m.p. 56–57°. (Found : C, 66.9 ; H, 7.3 per cent. $C_{14}H_{18}O_4$ requires C, 67.2 ; H, 7.2 per cent.)

α n-propyl-β-p-methoxy benzoyl propionic acid:—It was soluble in benzene, chloroform, hot ethyl acetate, hot methyl and ethyl alcohol and acetic acid. It crystallised from ethyl acetate in prisms m.p. 88–89°. (Found : C, 67.1 ; H, 7.3 per cent. Eqt. wt. 246.2. $C_{14}H_{18}O_4$ requires C, 67.2 ; H, 7.2 per cent. Eqt. wt. 250.) It formed a semicarbazone m.p. 145°. (Found : Eqt. wt. 305.6. $C_{15}H_{21}O_4N_3$ requires eqt. wt. 307.)

α n-amyl-β-p-methoxy benzoyl propionic acid :—It was freely soluble in all the solvents except petrol from which it crystallised in rectangular plates m.p. 80°. (Found : C, 69.1 ; H, 7.9 per cent. Eqt. wt. 276.1, $C_{16}H_{22}O_4$ requires C, 69.1 ; H, 7.9 per cent. Eqt. wt. 278.) It formed a semicarbazone m.p. 135°. (Found : Eqt. wt. 339.1. $C_{17}H_{25}O_4N_3$ requires eqt. wt. 335.) *Methyl-α-n-amyl-β-p-methoxy benzoyl propionate* was a colourless solid crystallising in prisms or plates from petrol m.p. 41–42°. (Found: C, 69.8 ; H, 8.3 per cent. $C_{17}H_{24}O_4$ requires C, 69.9 ; H, 8.2 per cent.

α n-hexyl-β-p-methoxy benzoyl propionic acid :—It was soluble in alcohol, benzene, ethyl acetate, chloroform and hot acetic acid. It crystallised from benzene or acetic acid in thick plates m.p. 92° (Found : C, 69.7 ; H, 8.4 per cent. Eqt. wt. 291.7. $C_{17}H_{24}O_4$ requires C, 69.9 ; H. 8.2 per cent. Eqt. wt. 292.) It formed a semicarbazone m.p. 142°. (Found : eqt. wt. 350.1 $C_{18}H_{27}O_4N_3$ requires eqt. wt. 349.)

α n-tetradecyl-β-p-methoxy benzoyl propionic acid :—It was soluble in hot alcohol, acetic acid, ethyl acetate, benzene and hot petrol. It crystallised from alcohol in granules m.p. 99-100°. (Found : C, 74.2 ; H, 10.0 per cent. Eqt. wt. 401.3. $C_{25}H_{40}O_4$ requires C, 74.3; H, 9.9 per cent. Eqt. wt. 404.) It did not from a semicarbazone under the usual conditions. *Methyl α-n-tetradecyl-β-p-methoxy benzoyl propionate* crystallised from petrol and had m.p. 45°. (Found : C, 74.5 ; H, 10.2 per cent. $C_{26}H_{42}O_4$ requries C, 74.7 ; H, 10.1 per cent.)

α n-hexadecyl-β-p-methoxy benzoyl propionic acid:—It was soluble in methyl and ethyl alcohol, hot benzene, acetic acid and petrol. It crystallised from dilute alcohol in plates m.p. 85–86°. (Found : C, 74.8 ; H, 10.3 per cent. Eqt. wt. 428. $C_{27}H_{44}O_4$ requires C, 75.0 , H, 10.2 per cent. Eqt. wt. 432.) It formed a semicarbazone m.p. 170-171. (Found : Eqt. wt. 487.7. $C_{28}H_{47}O_4N_3$ requires eqt. wt. 489.) *Methyl-α-n-hexadecyl-β-p-methoxy benzoyl propionate* was a colourless solid soluble in the common solvents crystallising from methyl alcohol in needles m.p. 38–39°. (Found : C, 75.3 ; H, 10.3 per cent. $C_{28}H_{46}O_4$ requires C, 75.3 ; H, 10.3 per cent.) *Ethyl α-n-hexadecyl-β-p-methoxy benzoyl, propionate* crystallised from alcohol in needles m.p. 41–42°. (Found : C, 75.6 ; H, 10.5 per cent. $C_{29}H_{48}O_4$ requires C, 75.7 ; H, 10.4 per cent.)

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M. R. SCIENCE INSTITUTE,
GUJARAT COLLEGE,
AHMEDABAD

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SYNTHESIS OF 5-HYDROXY INDANE

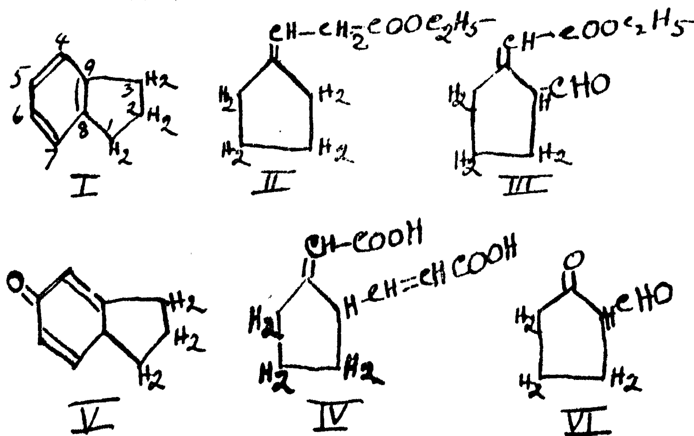
By

MISS K. PARANJAPE, N. L. PHALNIKAR AND K. S. NARGUND

5-HYDROXY indane (I) has already been prepared by the sulphonation of indane followed by fusion of the sulphonic acid with caustic potash. (Borsche and John B, 1924, *67*, 659. Cook and Linstead J. C. S. 1934, 946.) Paranjape, Phalnikar, Bhide and Nargund (Rasayanum 1943, *8*, in press) described methods to build up cyclohexadienones and the conversion of the latter into hydroxy benzene by fuming hydrochloric acid. These methods have now been applied to cyclopentane ring resulting in the synthesis of 5-hydroxy indane.

Ethyl cyclopentylidene acetate (II) on condensation with ethyl formate in presence of sodium gave ethyl-2-formyl-cyclopentylidene acetate (III), which on further condensation with malonic acid in presence of pyridine and piperidine, followed by hydrolysis gave cyclopentylidene acetic acid-2-β-acrylic acid (IV). Distillation of (IV) with a small amount of barium hydroxide gave 5-keto-$\Delta^{4,9}-\Delta^{6,7}$—dihydroindane (V). V could be prepared more conveniently and in better yield by the condensation of 2-formyl cyclopentanone (VI) with acetone in presence of sodium ethoxide. (V) on treatment with fuming hydrochloric acid in a sealed tube for 21 days at room temperature gave 5-hydroxy indane (I).

The above synthesis is interesting inasmuch as it provides a synthetic proof of the existence of cyclopentane ring in Indane.



EXPERIMENTAL

Ethyl cyclopentylidene acetate was prepared by Kon, Linstead and Maclennans method (J. C. S., 1932, 2455).

Ethyl-2-formyl-cyclopentylidene acetate (*III*) :—To finely divided sodium (2.3 gms) in ether (100 cc) was added with ice cooling a mixture of ethyl cyclopentylidene acetate (15.4 gms) and ethyl formate (7.4 gms). It was then left overnight when the reaction was complete. It was decomposed with ice water, ether layer removed and the aqueous layer acidified and extracted with ether, dried, and ether removed. No attempt was made to purify the substance by distillation under reduced pressure as it appeared to decompose. It gave violet colouration with ferric chloride and formed a semi carbazone m.p. 201°. (Found : in semicarbazone C, 53.0 ; H, 6.8 per cent. $C_{10}H_{17}O_3N_3$ requires C, 53.0 ; H, 6.8 per cent.

Cyclopentylidene acetic acid-2-β-acrylic acid. (*IV*):—A mixture of the above compound (18.2 gms) malonic acid (10.4 gms.) pyridine (7.9 gms) and piperidine (5 drops) was heated on water bath for six hours. It was then acidified with hydrochloric acid extracted with ether and ether removed without drying. The residue was hydrolysed by 20 per cent. aqueous alkali and the acid recovered by acidification was crystallised from dilute alcohol or petrol. It had m.p. 62°. The yield was 80 per cent. (Found : C, 61.3 ; H, 6.1 per cent. Eqt. wt. 98.4. $C_{10}H_{12}O_4$ requires C, 61.2; H, 6.1 per cent. Eqt. wt. 98.

5-keto $\Delta^{4,9}$ $\Delta^{6,7}$ dihydro indane (V) :—A mixture of the above acid (10 gms) and barium hydroxide (0,5 gms) was first heated at 150° and then at 180° under reduced pressure (80 mm.) till nothing distilled over. The distillate was freed from acid by washing with sodium carbonate and redistilled. It had b.p. 105° at 20 mm. 140° at 80 mm. yield 60 per cent. It had $D_4^{33}=1.0531$ $N_D^{33}=1.46216$. (Found : C, 80.5 ; H, 7.4 per cent. $C_9H_{10}O$ requires C, 80.6 ; H, 7.5 per cent.) It formed a semicarbazone m.p. 161°. (Found : C, 62.7 ; H, 6.8 per cent. $C_{10}H_{13}ON_3$ requires C, 62.8 ; H, 6.8 per cent.)

5-keto$\Delta^{4,9}\Delta^{6,7}$-dihydro indane (second method). A mixture of 2-formyl cyclopentanone (Wallach Ann, 1903, *329*, 109). (11.2 gms) and acetone (5.8 gms) was added with proper cooling to sodium ethoxide prepared from sodium (4.6 gms) and absolute alcohol (50 cc). It was then left overnight. Alcohol was distilled off, water added, extracted with ether, dried and ether removed. The residue distilled at 105° at 20 mm. and had properties identical with (V) described above. It formed a semicarbazone m.p. and mixed m.p. with the semicarbazone of (V) was 161°.

Conversion of 5-keto$\Delta^{4,9}$-$\Delta^{6,7}$-dihydro indane into 5 hydroxy indane-5-keto$\Delta^{4,9}$ $\Delta^{6,7}$ dihydro indane (5 gms) was mixed in a sealed tube with fuming hydrochloric acid (50 cc) and kept at room temperature for 21 days. It was then taken up with ether and ether layer washed with 10 per cent sodium hydroxide solution and the washings acidified. The solid thus obtained crystallised from dilute alcohol and had m.p. 55° and formed a benzoate m.p. 106-107°. They were identical (mixed m.p.) with authentic specimen of 5-hydroxy indane and its benzoate.

MAHARAJA PRATPSINHA
CHEMICAL LABORATORY,
S. P. COLLEGE, POONA

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∝-CHLORO-DIPHENYL ACETIC ACID AND ITS DERIVATIVES

By

(LATE) S. A. SETLUR, A. N. KOTHARE AND V. V. NADKARNY

R. STOLLE (Ber. 1910, 43.2471) had obtained the ∝ -chlorodiphenyl acetic acid in two different ways. In one method, benzilic acid was heated with excess of $POCl_3$ till the solution reddened ; in the other, 3 molecules of $SOCl_2$ were allowed to interact with one mole. of benzilic acid for several days, in an inert solvent like CCl_4. The yields in both the cases were however not very good. Recently, Setlur and Nadkarny (Pro. In. Ac. Soc., Vol. XII, Sec. A, 1940, 266-269) have obtained this acid in excellent yields from benzilic acid and PCl_5 or $SOCl_2$ under suitable conditions. This has enabled the present authors to study in some detail the derivatives of the acid.

The Cl atom in the ∝ -chloro-diphenyl acetic aid is very reactive and can be readily replaced by alkocxy, NH_2 and NH-R groups. In this way, the following derivatives have been prepared and studied.

(*a*) *Alkoxy derivatives*

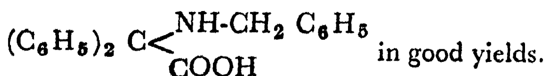
By the action of sodium methoxide and sodium ethoxide, on the chloro acid, ∝ -methoxy—and ∝ -ethoxy-diphenyl acetic acids have been obtained.

(*b*) *Amino-acid*

A small quantity of ∝ -amino acid is obtained by the action of concentrated aqueous ammonia or solid ammonium carbonate on the chloro acid. Much of the chloro acid however undergoes hydrolysis to form benzilic acid. With dry ammonia passed into an etheral solution of the chloro acid, a quantitative precipitate of the ammonium salt of the ∝ -chloro-diphenyl acetic acid was obtained.

(*c*) *Anilido derivatives*

(*i*) *With aliphatic amines.*—An aqueous solution of the following amines : methylamine, ethylamine and dimethyl amine were made to interact with the chloro acid, but the corresponding amino acids could not be isolated. Benzyl-amine however reacts with the chloro acid in benzene solution to give the benzylamine acid—



$$(C_6H_5)_2\,C{<}^{NH\text{-}CH_2\,C_6H_5}_{COOH}$$ in good yields.

(*ii*) *With aromatic amines.*—Klinger and Standke had obtained anilido-diphenyl acetic ester which on hydrolysis with alkali gave the correspon-

ding acid. In a similar way, p-toluidino diphenyl acetic acid was also prepared. We have prepared by direct interaction between the chloro acid and the toluidine the following derivatives. O-m-, α-toluidino-diphenyl acetic acids.

Of the three nitranilines, the m-nitraniline readily gives the m-nitranilido-diphenyl acetic acid. The ortho and para isomers do appear to react under the experimental conditions. An attempt to condense the chloro-anilines was unsuccessful ; with the α-and β-naphthyl-amines, products were obtained which could not be further worked up. Anthranilic acid gave readily the corresponding o-carboxy-anilido-diphenyl acetic acid. Sulphanilic acid under the same conditions gave no product.

(iii) *With cyclic amines.*—Piperidine reacts with evolution of heat to form the corresponding α-piperidino-diphenyl acetic acid.

Almost all the anilido-diphenyl acetic acids are rapidly hydrolysed. Concentrated H_2SO_4 on warming or standing for some time hydrolyses them completely as is indicated by the development of the blood red coloration. (A similar coloration is obtained by the action of Con. H_2SO_4 on the free chloro acid)

Experimental

Alkoxy-derivatives.—Equimolar quantities of the α-chloro acid and of Na-methoxide and Na-ethoxide are made to interact; Both the α-methoxy-and α-ethoxy-diphenyl acetic acids are obtained in crystalline forms.

α-methoxy-diphenyl acetic acid m.p. 100°C Found : C,74.41 ; H, 5.80 ; per cent. $C_{15}H_{14}O_3$ requires C, 74.39 ; H, 5.78 per cent.

α-ethoxy-diphenyl acetic acid m.p. 114°C. Found : C, 75.2 ; H, 6.45 ; per cent. $C_{16}H_{16}O_3$ requires C, 75.01 ; H, 6.25 per cent.

α-*amino-diphenyl acetic acid* :—Chloro-diphenyl acetic acid (20 gms) is ground with solid ammonium carbonate (30 gms). The mixture is then heated on the water-bath with stirring and concentrated ammonia (0.88) added till a paste is formed. Heating is continued till effervescence ceases. On cooling, water is added and finally dil. Hcl till precipitation is complete. The precipitate is washed with water. The α-amino-acid is obtained in small quantity, m.p. 245°C.

Analysis : 0.3224 gm requires 13.10 cc of 0.1077 N.NaOH.

Found : eq. wt.=228.4 ; calculated for $C_{14}H_{13}O_2N$, eq. wt.=227.1.

α-*Benzyl amino-diphenyl acetic acid.*—A solution of benzyl-amine (2 cc) in benzene is added to 10 cc of 10% solution of α-chloro-diphenyl acetic acid in benzene. The mixture is refluxed on a water-bath-for 1/2 hour and then the benzene distilled off. The residue is washed with dilute HCl and recrystallised from alcohol in fine white crystals. Con. H_2SO_4 gives a blood red colouration only on warming. M.P. 211°C (decomposes).

Analysis : 0.2728 gm requires 8.2 cc of 0.1077N. NaOH.

Found: eq. wt.=311.2; calculated for $C_{21}H_{19}O_2N$ eq. wt.=315.1.

α-*O-toluidino-diphenyl acetic acid.*—Prepared from O-toluidine (1.3 cc dissolved in 30 cc of C_6H_6) and α-chloro-diphenyl acetic acid (10% in C_6H_6) as above. Recrystallised from alcohol in white crystals. It is soluble in NaOH and Na_2CO_3 sols. Con. H_2SO_4 produces a yellow colour which turns red on warming. M.P. 150°C decomposes.)

Analysis : 0.384 gm requires 11.30 cc of 0.1077 N. NaOH.

Found : eq. wt. =317.5; calculated for $C_{21}H_{19}O_2N$, eq. wt. =315.1.

α *-m-toluidino-diphenyl acetic acid.*—Obtained from m-toluidine and chloro-diphenyl acetic acid in the same way as above. White crystals from alcohol. Con. H_2SO_4 gives a yellow colour which turns red on warming. M.P. 165°C (decomposes.)

Analysis : 0.0850 gm requires 2.50 cc of 0.1077 N. NaOH.

Found : eq. wt. =315.5; calculated for $C_{21}H_{19}O_2N$, eq. wt. =315.1.

α *-m-nitranilino-diphenyl acetic acid.*—Prepared from m-nitraniline (1.7 gm in C_6H_6) and α -chloro-diphenyl acetic acid (1gm in C_6H_6) as above. Crystallised from dilute alcohol in yellow crystals. Con. H_2SO_4 gives a blood red colour only on warming.

Analysis : 0.3127 gm requires 8.4 cc of 0.1077 N.NaOH.

Found : eq. wt. =345.6; calculated for $C_{20}H_{16}N_2O_4$, eq. wt. =348.1.

α *-o-carboxy-anilino-diphenyl acetic acid.*—Obtained from anthranilic acid (6.5 gms in C_6H_6) and α -chloro-diphenyl acetic acid (10 gms in 85 cc of C_6H_6). White crystals from alcohol. Con. H_2SO_4 gives a blood red colouration only on warming. M.P. 193°C (decomposes.)

Analysis : 0.2234 gms requires 12.2 cc of 0.1077 N. NaOH.

Found : eq. wt. =169.9; calculated for $C_{21}H_{17}O_4N_2$, eq. wt. =173.6.

α *-piperidino-diphenyl acetic acid.*—Prepared as above from piperidine (6gms in C_6H_6) and α -chloro-diphenyl acetic acid (8 gms in 50 cc of C_6H_6). Crystals separate with evolution of heat. The reaction is completed by refluxing on a water-bath for 1/2 hour. Fine white crystals from alcohol, Con. H_2SO_4 produces a blood red colouration on standing or warming. M.P. 180°C (decomposes.)

Analysis : 0.3445 gm requires 11.00 cc of 0.1077 N. NaOH.

Found : eq. wt. =290.7; calculated for $C_{19}H_{21}O_2N$, eq. wt=295.2.

SUMMARY

The following derivatives of α -chloro-diphenyl acetic acid have been obtained: α -amino-diphyl acetic acid, α -benzyl aminodiphenyl acetic acid, α -piperidino-diphenyl acetic acid, α -o-and m-toluidino-diphenyl acetic acid, α -m-nitranilino-diphenyl acetic acid, and α -o-carboxy-diphenyl acetic acid.

ST. XAVIER'S COLLEGE,
BOMBAY

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COMPONENT GLYCERIDES OF SAFFLOWER OIL

By

J. D. LAGAWANKAR, N. L. PHALNIKAR AND B. V. BHIDE

RECENTLY Vidyarthi (J.I.C.S, 1943, *20*, 45) has reported his results on the glyceride composition of safflower oil. Work on similar lines has also been carried out in this laboratory. Our results are markedly different from those of Vidyarthi (*loc. cit.*) and hence are described in this communication.

EXPERIMENTAL AND RESULTS

The safflower seeds (Carthamus Tinctorius), Linn. (N. O. Compositae) used in this work were purchased from the local markets (Poona District). The properties of the cold pressed oil are given in Table I along with those found by Vidyarthi (*loc. cit.*).

TABLE I

	Present work	Vidyarthi
Density at 30°c	0.9168	0.9242 at 27°c.
Refractive index at 30°c	1.47287	1.4742 at 27°c.
Saponification Value	188.1	192.0
Iodine Value (Rosenmund Kuhnhenn method)	125.4	136.2 (Wij's)
Acid Value	2.44	6.3

The composition of the fatty acids was also determined according to the usual methods and the results are given in Table

TABLE II

	Present work	Vidyarthi (*loc. cit.*)
Myristic acid and other lower acids ..	0.42	1.5
Palmitic acid	2.08	2.9
Stearic acid	2.01	1.1
Arachidic acid	1.22	0.5
Oleic acid	37.58	32.8
Linolic acid	56.67	61.1
Linolenic acid	....	trace.

It will be seen that the analytical figures agree with those obtained by Vidyarthi (*loc.cit.*) within reasonable limits.

Component Glycerides of Safflower Oil :—

A preliminary examination of the oil showed the absence of fully saturated or disaturated glycerides. The component glycerides were, therefore, determined by brominating the neutral oil and separating the bromoglycerides according to the methods of Vidyarthi and Mallya (J.I.C.S., 1940, *17*, 87). The following table gives the general scheme of separation and fractionation of the brominated glycerides.

TABLE III

Neutral Oil (50.2 gms.)
Brominated in Hexane (500 c.c.)

Insoluble — extracted with alcohol (250 c.c.)
- Insoluble F_1 (47.38 gms.)
- Soluble F_2 (4.12 gms.)

Soluble — Extracted with alcohol (100 c.c.)
- Insoluble — extracted with alcohol and acetone (1:1) (100. c.c.)
  - Insoluble F_5 (10.77 gms.)
  - Soluble F_4 (21.04 gms.)
- Soluble F_3 (8.26 gms.)

Vidyarthi (*loc. cit.*) does not determine the percentage of bromine in the various fractions. We have determined the bromine percentage in each fraction and the probable composition of the component glycerides was obtained from the theoretical percentage of bromine in the different possible glycerides.

The following Table gives the theoretical percentage of bromine in the various possible glycerides. These values were used in determining the probable glyceride composition from the bromine percentage experimentally found :—

TABLE IV

	Glyceride Brominated	% Bromine
1	Trilinolin	52.2
2	Mono-oleo-dilinolin	47.62
3	Mono-saturated-dilinolin	42.36
4	Di-oleo-mono-lonolin	42.06
5	Mono-saturated-oleo-linolin	35.5
6	Triolein	35.19
7	Mono-saturated-di-olein	33.7

The following table gives the bromine percentage in the fractions experimentally determined along with the probable composition :—

TABLE V

Fraction No.	% of bromine found	Probable composition
F_1	50.2	Trilinolin with a small quantity of mono-oleo dilinolin
F_3	42.46	Monosaturateddilinolin, Dioleomonolinolin
F_4	40.2	Mixtures of monosaturated dilinolin, dioleolinolin, monosaturated oleolinolin, triolein and monosaturated diolein
F_5	40.3	
F_2	37.1	Triolein or monosaturated oleolinolin or a mixture of these with a trace of trilinolin

To determine the exact composition of these fractions each fraction was debrominated with zinc and alcohol according to the procedure given by Brown and Frankel (J. A. C S.. (1938, *60*, 54). The following table gives the iodine values and equivalent wts. of the regenerated acids from each fraction after debromination :

TABLE VI

Fraction No.	I. V. (Found)	I. V. (Calc. from Br %)	Equi. wt.
F_1	112.9	179	282.9
F_2	95.4	91.0	280.6
F_3	98.7	122.0	280.4
F_4	105.7	112.0	275.7
F_5	105.3	112.0	278.8

It will be seen that excepting the fractions F_1 and F_3 the iodine values of the regenarated acids from the remaining fractions, although somewhat low, agree within reasonable limits with the values calculated from the bromine content.

The debrominated acids were separated into solid and liquid acids and the liquid acids were identified by oxidation. The solid acids were too small in quantity to allow a separation into individual acids.

Fraction F_2 :—No solid acid could be detected. Linolic acid was also found to be absent, hence this fraction contained only oleic acid.

Fractions F_4 and F_5 :—These two fractions contained solid acids. 2.65 gms. of solid acids *i.e.*, 5.3% on the wt. of the oil were found in these two fractions. The oil contains only 5.74% solid acids. These two fractions, therefore, account for most of the solid acids present in the oil. Solid acids were not found in any other fraction.

Fractions F_1 and F_3 :—It will be seen that the debromination of fractions F_1 and F_3 gives expected equivalent wts. of regenerated acids, but the iodine values are too low as compared with the iodine values calculated from the bromine content. The debrominated products did not contain any bromine. This shows that the debromination of fractions F_1 and F_3 did not proceed smoothly. Moreover fraction F_1 should have been a solid according to Vidyarthi (*loc. cit.*) but all attempts to crystallise failed. Fractions F_1 and F_3 were dark viscous oils. These were debrominated using different methods (K. Kino. Sci. Papers. Inst. Phys. Chem. Res. Tokyo, 1935 .*26*, 91), and Black and Overley J. A. C. S., (1939, *61*, 3051) but in each case the iodine value of the debrominated acid was always lower by several units than that calculated from the bromine content. The debrominated acids on rebromination in hexane did not give the solid tetrabromostearic acid but a dark oil separated. This did not solidify even on seeding with a crystal of pure tetrabromostearic acid (m.p. 114°.). Evidently the debromination does not

proceed in the normal way. Some bromine atoms are being replaced by hydrogen and probably an isomer of linolic acid is produced, which gives liquid tetrabromide. The composition of these fractions, therefore, remains in doubt. The bromine content of fraction F_1, however, indicates it to be trilinolin mixed with a small quantity of oleodilinolin. The glyceride composition has been, therefore, calculated assuming F_1 to be trilinolin and F_3 to be dioleolinolin. The results are given in the following Tables :—

TABLE VII

	Wt. of the oil taken=50.2 gms.				
	F_1	F_2	F_3	F_4	F_5
Wt. of bromoglycerides.	47.38	4.12	8.26	21.04	10.77 gms.
Wt. of debrominated glycerides ..	23.58	2.624	4.75	12.59	6.36 gms.
Wt. of acids ..	20.51	2.283	4.132	10.95	5.53 gms.

Individual acids in each of the above fractions are given in the following Table :—

TABLE VIII

	F_1	F_2	F_3	F_4	F_5	Total
Saturated acids —	..	..	..	1.75	0.9	2.65 gms.
Oleic acids ..	..	2.28	2.75	6.85	3.46	15.35 gms.
Linolic acid ..	20.51	..	1.37	2.35	1.16	25.4 gms.

Component glycerides in the oil are given in the following Table :—

TABLE IX

	F_1	F_2	F_3	F_4	F_5	Total in 100 gms. of oil	Vidyarthi (*loc. cit.*)
Monosaturated oleolinolin ..	..	..	..	5.88	3.03	17.85	18.6
Dioleomonolinolin..	..	..	4.56	1.86	0.85	14.57	14.8
Triolein ..	..	2.58	..	4.33	2.24	18.31	..
Trilinolin ..	22.69	..	..	..	..	45.38	2.9
Mono oleodilinolin	..	..	..	..	..	..	63.7
Unsaponifiable ..	..	..	..	..	..	2.0	..
Unaccounted ..	..	..	..	..	..	2.0	..
Total ..	..	..	..	..	..	100.0	100.0

The following Table gives the percentages of the various acids obtained from the analysis of the oil and from the glyceride composition of the oil, which agree very well :—

TABLE X

Acids	Percentages of acids on 100 gms. of oil	
	From analysis	From glyceride composition
Saturated acids ..	5.0	5.3
Oleic acid ..	32.8	30.7
Linolic acid ..	49.2	50.8
Total on 100 gms. of oil ..	87.0	86.8

It will be seen from Table IX that the percentages of monosaturated oleolinolin and dioleolinolin agree very well with those obtained by Vidyarthi (*loc. cit.*), but the percentages of triolein and trilinolin are quite different. The difference may be due to the different localities in which the plants were grown. The debromination of the brominated trilinolin fraction F_1 is being studied further.

MAHARAJA PRATAPSINH CHEMICAL LABORATORY, SIR PARASHURAMBHAU COLLEGE, POONA

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POLYMORPHISM AND DIELECTRIC CONSTANT

By

S. D. GOKHALE, N. L. PHALNIKER AND S. D. BHAVE

IN continuation of the work of Bhide and Bhide (Bom. Uni. Journal, Vol. VIII, part 3, 220, 1939) investigation of the polymorphism of some more substances was undertaken. Pauling (The nature of the Chemical bond, Cornell University Press, 1940) has discussed the hydrogen bond formation of several organic compounds. In this paper the polymorphism of the following hydrogen bonding compounds has been studied: (i) Resorcinol, (ii) p-Nitrophenol, (iii) o-Nitrophenol, (iv) p-chlorophenol, (v) o-Chlorophenol.

EXPERIMENTAL WORK AND RESULTS

Purification of substances :—The substances were pure samples from either Merck or Kahlbaum. The chlorophenols were purified by distillation. Resorcinol was purified by distillation under reduced pressure. p-Nitrophenol was crystallised from water containing a little hydrochloric acid. o-Nitrophenol was crystallised from methyl alcohol.

Measurement of the dielectric constant:—The apparatus was the same as used by Gokhale, Phalniker and Bhave (Bom. Uni. Journal, Vol. XI, part V, 56, 1943). The following experiments were carried out for each of the substances for the measurement of the dielectric constant, at two wavelengths, 520 m. and 90 m.

(I) The melted substance was cooled gradually below its melting point and the frozen solid cooled further. Capacities were measured at intervals. The corresponding curve is shown as 0—0—0—.

(II) The solid was heated till it melted completely and heated a few degrees further. The curve is shown as △————△————△————△————

(III) The melt was suddenly chilled by surrounding the container with a freezing mixture till it attained the lowest temperature and the solid was heated somewhat rapidly to a temperature a few degrees above its melting point, the measurement of capacities being carried out from time to time. The curves are drawn as ×——×——×—

RESORCINOL

This substance has been investigated by Robertson (Nature, *136*, 755, 1935), Robertson and Ubbelohde (Proc. Roy. Soc., *167*, 122, 1938) who have studied the transition

and the crystal structure of the two forms α and β. The α—form is stable at ordinary temperatures and crystallises in long needles while the β—form crystallises in plates. The transition takes place at about 74° C. The heat of transition is small—about 220 gm-cal. When the temperature is raised the rigidity of the molecules breaks down, the O—H bonds are distorted and the result is a compact structure of higher density.

In our experiments the transitions are indicated by breaks in the temperature—DC (dielectric constant) curves. The curves in Figure 1 for both the frequencies show breaks between 74°C and 78°C. The changes in the values of the dielectric constant are very small.

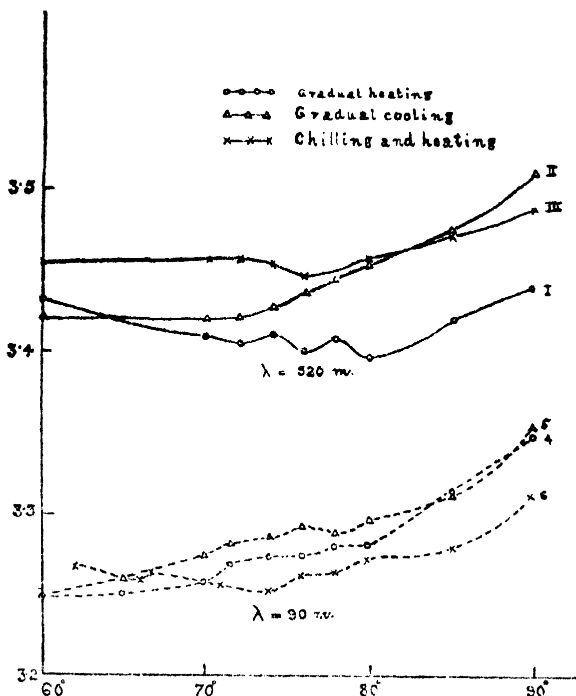


FIG. 1—RESORCINOL

p-NITROPHENOL

p-Nitrophenol crystallises in two forms. (*i*) The α—form, colourless prisms obtained by crystallisation from toluene above 63° C., metastable at ordinary temperatures and stable to light. (*ii*) the β-form :—Yellow prisms obtained by crystallisation from toluene below 63° C., stable at ordinary temperatures and gradually turns red on exposure to daylight. It appears that the α-form is stable above 63° C and melts at 114° C.

In the present work needles obtained by crystallisation from water containing a little hydrochloric acid were used. These crystals gave 114° C. as the melting point in a capillary tube.

The results are represented by curves, Figure 2. The curves I and II corresponding to the processes—gradual cooling and gradual heating—do not show any unusual characteristics. The colour was white in both the stages. The DC shows a rapid rise in values from 90° C. right upto the melting point. This is probably due to the breaking up of the hydrogen bond between the adjoining molecules in the crystal lattice and rotation.

When the substance is melted and suddenly chilled and the temperature then raised the DC gradually falls till 63° C is reached. The chilled melt has patches of yellow colour. The rise in DC between 63° C and 90° C. is only slight but after 90° C. the rise is as rapid as in other experiments. (Curve III—Fig. 2).

63° C. seems to be the temperature at which the transition from metastable to the stable form takes place.

A very important observation is the abnormally high value of the DC in the liquid condition. It is as high as 174 at 120° C.

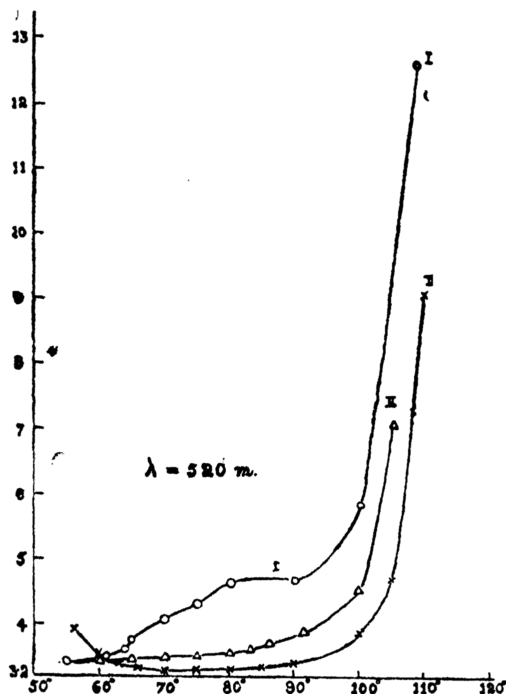


FIG. 2—P-NITROPHENOL

O-NITROPHENOL

Yellow needles obtained by crystallisation from methyl alcohol were used. The melting point was 44°.9C. (In the DC experiments the thermometer put in the substance showed a melting point 44° C.). The DC measurements were carried out in the usual manner. The results are represented by curves, Figure 3.

The DC of the melt was 17.17 at 90m. and 16.18 at 520 m.; these high values are to be expected from the polar character of the substance.

At 520 m. all the curves (I, II and III, Fig. 3) show a rapid fall in DC from about 16 at the melting point to about 3.5 at 30° C. then a slight rise to about 3.6 at 30°C. and then a gradual fall. The minimum at 35° C. is repeated in all the experiments. At 90 m. the minimum was marked only after chilling and heating (Curve VI, Fig. 3) and it occurred at 40° C. instead of at 35° C. The high values at low temperatures after chilling and heating are due probably to some of the molecules not being fixed up in the crystal lattice. The DC falls on account of the molecules getting gradually fixed up.

After an experiment the condenser was left at room temperatures and capacity measurements carried out at 28° C. every day. The capacity diminished for the first two days and was then practically steady. When this was gradually heated to the melting point, no break in the temperature—DC curve was noted, indicating that stable form was obtained.

Thus o-Nitrophenol can exist in two forms, the transition temperature being 35° C. The higher temperature form is stable and the lower temperature form metastable. The change is enantiotropic.

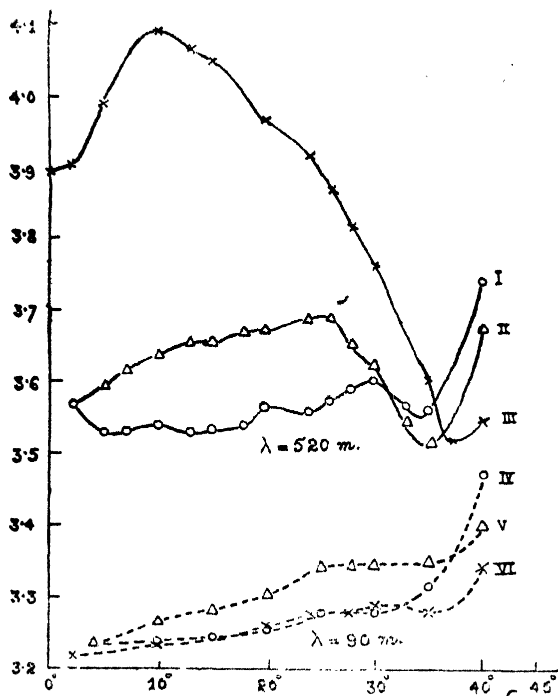


FIG. 3—O-NITROPHENOL

P-CHLOROPHENOL

p-Chlorophenol is a solid at room temperatures. It was purified by distillation, the fraction boiling at 212° C. at about 710 mm. being collected separately. The resulting liquid did not solidify at room temperature—even on keeping for several days. The substance was chilled in ice. No solidification took place till the temperature fell to about 12° C. and then the substance froze suddenly. It was kept in ice sufficiently long to cool it to 3°.5 C.

DC measurements were carried out at 520m., while the solid was heated somewhat rapidly. The substance was seen to melt at 33° C. The changes in DC in the solid condition were small while the DC in the liquid condition at 35° C. showed a very high value *viz.*, 10.3 and at 43° C. it was 9.93. (Curve III, Fig. 4). The values were retraced during cooling and the substance froze at 33° C. It was allowed to cool to 5° C. (Curve II, Fig. 4).

The substance was then gradually heated. The DC values were repeated till 30° C.; but now the substance did not melt at 33° C. It was found to melt at 41° C. Readings were continued till 46°C. The readings in the liquid state were consistent with those in the previous processes. (Curve I, Fig. 4).

The melt in the last stage was allowed to cool overnight. It was found to have frozen—not supercooled as the one melting at 33°C.—with the room temperature at 30° C. The DC was slightly higher than the corresponding one the day before. On heating to 35°C. it did not melt, nor did it show any abnormal rise in DC: but it melted at 41°C., showing that a stable form was obtained which did not melt at 33°C.

Experiments at 90 m. gave a repetition of the nature of the curves. (Curves IV, V and VI, Fig. 4).

The substance has two distinct forms, one obtained by chilling the melt, the form being metastable with melting point 33°C.; while the substance obtained by gradual solidification is stable and has melting point 41°C. There is no definite transition from one form to another.

The substance can form only a weak hydrogen bond between the Cl atom of one molecule and the H atom of another molecule.

The form melting at 33°C. has not been noted by previous workers.

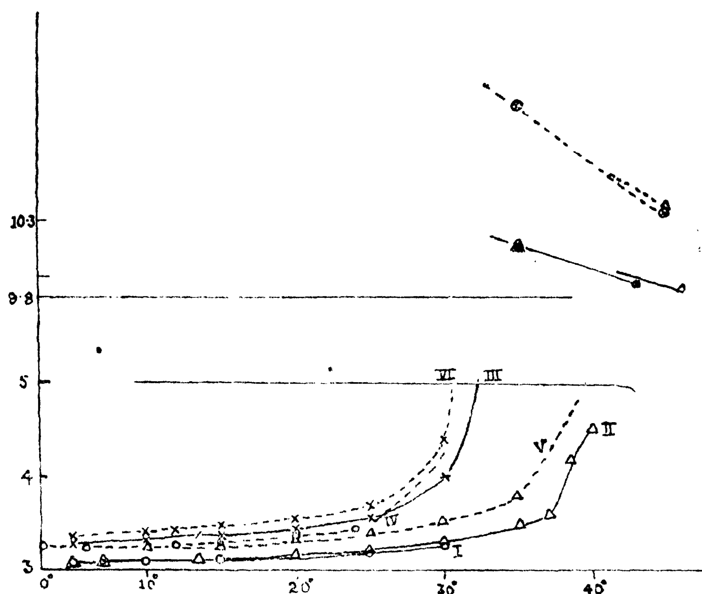


FIG. 4—P-CHLORPHENOL

O-CHLOROPHENOL

o-Chlorophenol has two configurations. The infra-red spectra of a solution of the substance in carbon tetrachloride show that o-chlorophenol exists in cis form to the extent of 91% and in the trans form to 9%. (Errera and Mollet, J. de Phys. et le radium, *6*, 281, 1935). It is a liquid at ordinary temperatures, and crystallises in three different forms melting at 7°C., 0°C. and —4°C. respectively.

In our experiments, o-chlorophenol was purified by distillation (b. p. 176°C. at about 710 mm.). The purified sample was put in the condenser. It was then cooled to—15°C. and allowed to solidify and the temperature was gradually raised. The DC measurements were carried out at wavelengths 520 m. and 90 m.

The results are represented by Figure 5.

If the curve corresponding to 520 m. is followed from —15°C. onwards, there is a break at —11°C. This is due very probably to some of the molecules not being fixed up in the crystal lattice, some molecules being in the glassy state due to rapid chilling of the liquid. After —11°C. the DC rises rapidly till —3°C. is reached, then there is a slight fall and a minimum is obtained at —1°C. and the rise is very slow till 2°C., then the rise is very rapid and the substance melts at 7°C. The DC is not very high.

The curve corresponding to 90m. shows a minimum at —8°C. The higher value of DC at —9°C. may be due again to some of the molecules not being fixed up in the crystal lattice.

There is a pronounced minimum at —3°C. and a break of another nature at 0°C., *viz.*, a very rapid rise in DC indicative of a transition.

The substance finally melts at 7°C.

The results indicate transitions at —4°C., 0°C. (—1) and 7°C. ; so that the substance exists in three forms with transitions at —4°C., 0°C. and 7°C. The forms are interconvertible.

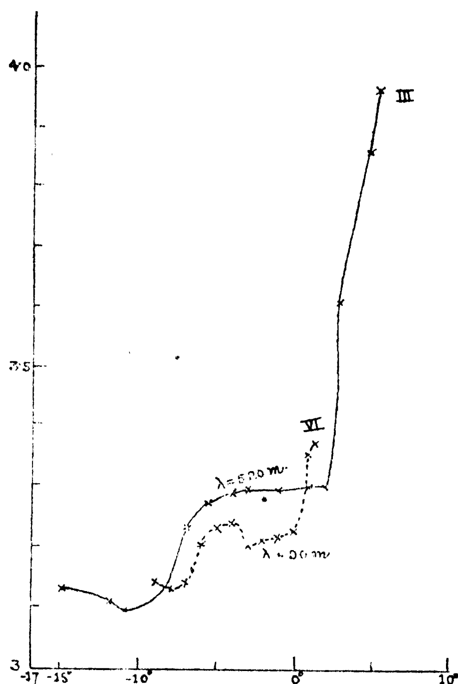


FIG. 5—o-CHLOROPHENOL

SUMMARY OF RESULTS

The polymorphism of the following hydrogen bonding substances has been studied. The dielectric constants of these compounds have been measured in suitable ranges of temperatures and at wavelengths 520 m. and 90 m. (i) Resorcinol, (ii) p-Nitrophenol, (iii) o-Nitrophenol, (iv) p-Chlorophenol, (v) o-Chlorophenol.

The following Table gives the comparative results.

Substance	Form	m.p.	Transition temperature	
			This paper	Previous work
Resorcinol	α	114	74-78	74
	β	110		
p-Nitrophenol	α-stable	114	63	63
	β-unstable			
o-Nitrophenol	α-stable	45		
	β-metastable		35	Not noted
p-Chlorophenol	α-stable	41		
	β-metastable	33	No definite transition ; the form has not been noted	
o-Chlorophenol		7	—4, 0 (—1), 7	—4, 0 and 7

We are thankful to Professor B. V. Bhide, Head of the Chemistry Department, for the interest he took during the progress of the work.

PHYSICS DEPARTMENT,
S. P. COLLEGE, POONA

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A STUDY OF THE ENZYMES PRESENT IN GERMINATING SEEDS

By

N. V. Bhide and D. L. Sahasrabuddhe

SINCE 1842 the study of the germinated grains has been carried out by a number of workers, many of whom have concentrated their attention mainly on oil-seeds. Some of the workers in this field are De Saussare (Uber. Des. Chemen. Der. OcesamEscieen—Poripp Notium, 1842, pp. 24.), Helriegel (Bot. Ztg., 1859, pp. 187), Brown and Morris (Jour. Chem. Sec., 1895, LVII, pp. 485), and Sahasrabuddhe and Kibe (J. Uni. Bom., 1934, Vol. III, Part 2). These workers have studied the enzymes in the extract of the seeds by using either pure fat or pure starch as the substrate. It is proposed to study the amylase and proteinase activities of the extract of the germinated grains employing the flours of the same grains as substrate. The flours of the following grains were used :

1. Bajri (Pennisetum typhoideum),
2. Vari (Panicum milaceum),
3. Gram (Cicer arietinum),
4. Black-gram (Phaseolus radiatus).

Preparation of the Enzyme Extract

Twenty grams of Bajri seeds were soaked in water for three hours and kept aside for germination with usual precautions. Samples were removed after every twenty-four hours, crushed and extracted with 250 c.c. of water, filtered and the extract thus obtained was subsequently used for its amylase and proteinase activity.

Amylase Activity of the Enzyme Extract

1 gram of each of the flours was geletanised in 50 c.c. of water in boiling water bath for ten minutes and on cooling to the room temperature, 10 c.c. of the enzyme extract were added together with 30 c.c. of the acetate buffer solution of pH 4.8. After the intervals of 1, 2 and 3 hours the enzyme was inactivated by 5 drops of NaOH (10%), clarified with ZnO, the volume was made (100 c.c.), filtered and 10 c.c. of the filtrate were used for the determination of the reducing sugar by Bertrand's method. The percentage hydrolysis was expressed on the basis of the total hydrolysable starch as determined by the method given in the methods of analysis of A. O. A.-e, 1926, p 119, (oven-dry). The results have been given in Table 1.

TABLE I

Percentage hydrolysis of the Flours with enzyme extract (Bajri amylase) expressed on the basis of the total hydrolysable starch

Name	Extract after 24 hours			Extract after 48 hours			Extract after 72 hours			Total hydro-lysable starch
	1 hr.	2 hrs.	3 hrs.	1 hr.	2 hrs.	3 hrs.	1 hr.	2 hrs.	3 hrs.	
Bajri flour ..	5.05	8.16	10.88	11.39	22.27	24.99	16.15	26.01	28.73	59.82
Vari flour ..	4.37	7.69	10.70	10.26	16.15	21.47	15.58	23.18	25.27	56.23
Gram flour ..	6.44	7.59	12.42	9.89	18.66	21.16	14.26	20.08	25.74	42.32
Black-gram flour ..	4.00	6.20	8.22	8.20	24.60	27.00	11.60	14.80	18.00	50.87

It is seen that the extract of the germinated Bajri seeds contained an active amylase which can hydrolyse the starches from the flours of different grains which include both the cereal and pulse grains. Although the enzyme is obtained from Bajri seeds it is not behaving in any special way towards Bajri flour. The activity of the amylase goes on increasing for the first 72 hours, then it begins to decrease (Table 2).

TABLE 2

The activity of the Bajri amylase from day to day of the germination expressed on the total hydrolysable starch from Bajri

Period of germination	1 hour	2 hours	3 hours	% of Total hydrolysable starch
24 hours ..	5.01	8.16	10.88	59.82
48 hours ..	11.39	22.27	24.99	59.82
72 hours ..	16.15	26.01	28.73	59.82
96 hours ..	7.82	15.47	23.46	59.82

(B)

THE PROTEOLYTIC ENZYMES FROM BAJRI SEED EXTRACT

For studying the proteolytic activity the enzymes extract was prepared in exactly the same way as above. The activity of the enzyme was expressed in mgm. of amino-nitrogen as determined by the Van Slykes method.

EXPERIMENTAL

1 gram of the flour was suspended in 10 c.c. of water and 10 c.c. of the phosphate buffer of pH 9.6 (which was found to be the optimum) together with 10 c.c. of the enzyme extract were added and kept at 37°c. The activity of the enzyme was killed with dialysed iron 5 c.c. followed by Magnesium sulphate (50%) solution, the volume was made up (100 c.c.).

It was filtered and 5c.c. of the filtrate were used for the determination of the amino-nitrogen by Van Slykes method. The results are given in Table 3.

TABLE 3

Hydrolysis of the flours with enzyme extract (proteolytic from Bajri seeds) expressed as mgms. of amino-nitrogen per 100 gms. of the flour

Name	Extract after 24 hours			Extract after 48 hours			Extract after 72 hours			% of Total proteins in the flours
	1 hr.	2 hrs.	3 hrs.	1 hr.	2 hrs.	3 hrs.	1 hr.	2 hrs.	3 hrs.	
Bajri flour ..	188.0	227.8	269.8	269.2	310.6	331.3	310.5	352.4	372.7	9.6
Vari flour ..	20.70	82.8	168.0	40.3	145.0	207.3	103.4	186.2	227.8	7.53
Gram flour ..	209.13	316.2	385.2	315.2	420.8	492.3	517.6	579.8	579.8	20.03
Black-gram flour ..	242.80	367.9	420.2	375.9	490.2	520.6	641.2	724.4	744.5	23.21

The proteolytic enzymes from Bajri seeds act well on all the flours. The activity of the enzyme goes on increasing as in the case of the amylase. The pulse flours give higher values of hydrolysis than the cereal flours, as they contain a higher percentage of proteins. The order of the suceptibility was found to be as Udid (Black-gram), Gram, Bajri and Vari. It may be stated that the comparison is made on the basis of the weights of the flours without any consideration of their protein contents. The activity of the anzyme was maximum at the end of the 72 hours. It then began to decrease.

II

ENZYMES FROM GRAM SEED

Gram—Amylase:—The enzyme was not obtained in the form of the extract as above as the process was found to be impracticable due to the difficulties in filtration, adjusting the equality of the number of seeds, etc. The plimules of the germinated seeds were cut and dried at 55°c, powdered and used as such. The changes in the activity of the enzyme along with the advancing period of germination could not obviously be studied as before. The experimental procedure was exactly the same as in the previous case except that the buffer used was of pH 5.2 instead of 4.8 as it was found to be the optimum. The results are given in Table 4.

TABLE 4

Hydrolysis of the flours with gram-amylase expressed on the basis of the total hydrolysable starch

Name	1 hour	2 hours	3 hours	% of Total hydrolysable starch
Bajri flour ..	2.38	5.37	13.74	59.82
Vari flour ..	2.47	4.94	14.13	50.23
Gram flour ..	4.6	5.98	17.11	42.32
Black-gram flour ..	4.0	5.30	161.8	50.37

It is seen that the enzyme has a preferential action on the flours. The flour of the seed from which the enzyme is obtained is more easily hydrolysed than any other flours.

GRAM-PROTEINASE

The experimental procedure was the same as in the case of the Bajri seed except that the buffer solution used was of pH 9.0. The results are given in Table 5.

TABLE 5

Hydrolysis of the flours with gram-proteinase expressed as mgms. of amino-nitrogen per 100 gms. of the flour

Name	2 hours	3 hours	% of Total proteins
Bajri flour ..	182.3	217.4	9.6
Vari flour ..	90.4	123.5	7.53
Gram flour ..	253.3	333.3	20.03
Black-gram flour ..	294.0	430.8	23.21

SUMMARY

(i) The activity of the amylase and proteinase from the extracts of the germinated Bajri and Gram seeds was studied by using the flours of Bajri, Vari, Gram and Black-gram as substrates.

(ii) The extract of the germinated seeds was found to contain both amylase and proteinase which act equally well on the flours of all the grains studied.

(iii) The activity of the enzymes goes on increasing for the first 72 hours, it then begins to decrease.

DEPARTMENT OF BIOCHEMISTRY,
N. WADIA COLLEGE, POONA

[*Received: June 28, 1943*]

SCIENCE NOTES

Photoelectric Measurement of the Intensity of Scattered Light

By

G. R. Paranjpe and R. V. Tamhankar

In the course of investigations, carried out on the azimuthal distribution of intensity of monochromatic light scattered by a cloud of water droplets, a number of photoelectric circuits were tried with a view to measure continuously the intensity of the scattered light in the horizontal plane. The main difficulty lies in the fact that the scattered light is too feeble to be detected, and therefore requires the highest type of sensitivity

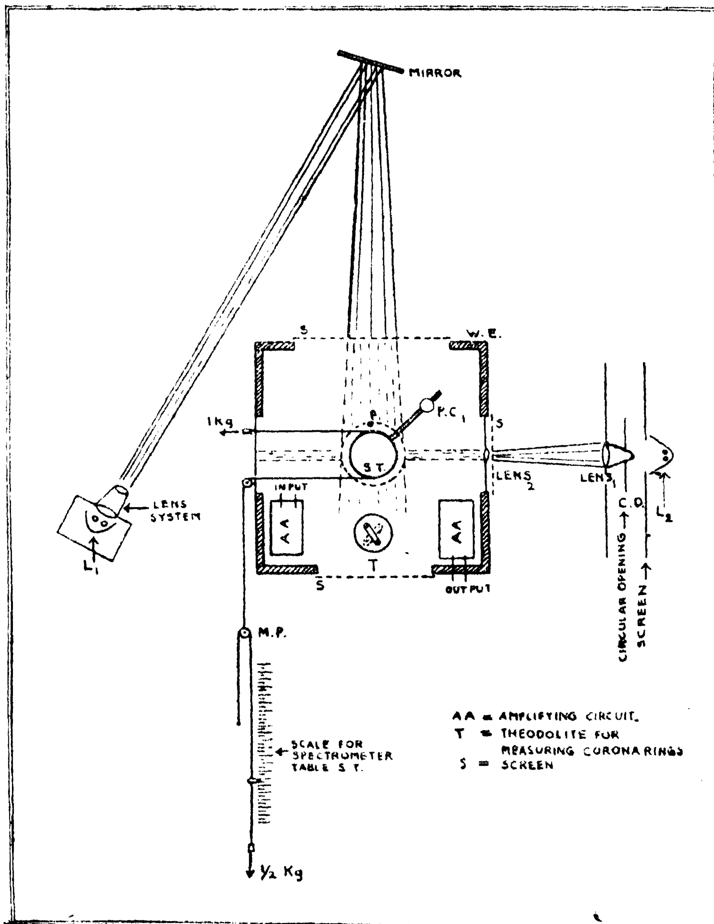


Fig. I

in the measuring devices. It was found that most of the photoelectric amplification circuits, if sufficiently sensitive, have a tendency to become unstable and *vice versa*. A circuit of the Balanced Photo-Cell type was therefore set up which was found to satisfy both the requirements. A diagrammatic sketch is shown in Fig. I.

AMPLIFYING CIRCUIT

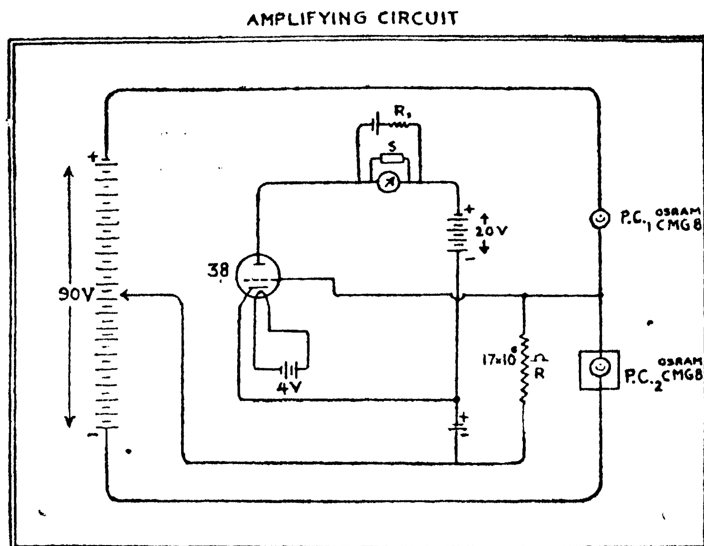


Fig. II

A sketch of the general experimental arrangements is also given in Fig II. S. T. is a table on which is kept the cloud chamber F. The photo-cell PC_1 receiving the scattered light is held vertically on a rod fixed to the axis of a pulley of about 20 cms diameter. The pulley is thus capable of rotating the photo-cell arm round the cloud chamber F which is kept fixed on a rigid base and receives a beam of incident light. The motion of the pulley is made as smooth as possible by means of bearings. An inextensible cord passing over the pulley supports a weight of 1 kg at one end, the other end being connected to a movable pulley M.P. sliding over a horizontal surface. To the cord on the movable pulley is attached a pointer which indicates the degrees through which the photo-cell arm turns with reference to the parallel beam from lamp L_2. The linear scale is calibrated in degrees with least count of 1″. The movable pulley gives the advantage of doubling the scale thus making finer adjustments possible. It was found that the pulley arrangement worked very satisfactorily. The movements of the PC_1 arm were perfectly reproducible. The friction drive was reliable and even a small movement of the outside pointer made a corresponding movement of the photo-cell arm. The pulley arrangement served another advantage, that of producing a smooth movement of the photo-cell arm thus eliminating all defect due to shocks and contact by hand.

The photo-cell was clamped to the spectrometer arm rotating round the cloud chamber. The height of the photo-cell could be adjusted so as to receive the scattered energy normally on the photo-sensitive surface. This cell was connected to the rest of the circuit by thick lead covered

and externally earthed cable. The cable was twisted loosely round the table to avoid jerks on the photo-cells and the valve due to the movement of the rotating arm.

The other photo-cell (PC_2) and the amplifying valve (38) were also mounted on porcelain bases fixed on a bakelite board. The batteries were placed as near the circuit as possible so that very short connecting wires were sufficient. All joints were soldered with tin in order to avoid bad contacts. Special type of cables and wires were used.

It was found that the circuit became more sensitive when the grid leak resistance (R) was increased. But it also made the circuit unstable. Trying with various resistances it was found that a resistance of 17 megohms gave good sensitivity without upsetting the stability of the circuit.

The photo-cell circuit initially gave a dark current of several microamperes. This current was neutralised by connecting an opposite E.M.F. to the galvanometer circuit from a 2 volt storage cell controlled by suitable potentiometer arrangement. Two galvanometers were placed in parallel with each other in the output arm and either of them could be brought into circuit at will. One of these was a Weston milliammeter and the other a sensitive, perfectly dead beat suspended coil mirror galvanometer. The milliammeter served as a rough instrument for balancing the potentiometer circuit so that the fluctuations might not harm the other more sensitive instrument. When the circuit reached a steady stage the mirror galvanometer was switched on and the deflections of the reflected light beam on a scale placed at a distance of about three meters were taken proportional to the intensity of light falling on the receiving photo-cell (PC_1).

In practice, it was found that, after switching on the various connections, an hour or so elapsed before the circuit.

The photoelectric circuit consisted of two identical photo-cells and a high amplification valve. One of the photo-cells (PC_1) is used to receive the scattered energy while the other (PC_2) is completely darkened. The main feature of the circuit is that extremely minute differences of the intensities of light falling on the two cells can be detected. The sensitivity of the circuit reaches its maximum when one of them is kept in absolute darkness.

This amplifier circuit like many others, was also found to be very highly susceptible to leakages and external electrical disturbances. Contact with any wire in the circuit or with the table on which the circuit was kept, produced uncontrollable fluctuations in the galvanometer. Anything electrical, even a lamp worked in the vicinity, disturbed the equilibrium of the circuit. It was therefore constructed using material having special insulating properties and mounted in as compact a form as possible. The ebonite frame of the circuit including even the batteries was kept in a chamber lined with thick lead sheet and properly earthed at several places, in order to protect the circuit from stray local electrical disturbances.

The cell used for receiving the scattered energy (PC_1) was mounted separately on a porcelain valve holder screwed to a thick bakelite board. The board was supported on a vertical rod.

Two cylindrical brass caps were fitted round the photo-cells. They were painted dull black from inside to avoid reflections and stray light. They were further covered with thick black cloths to insure darkness. They were also earthed to avoid external electrical disturbances.

A rectangular slit was cut in the cap fitted to the receiving photo-cell. The width of the slit was 0.5 cm and height equal in length to the sensitive surface of the cell. A similar slit was placed parallel to the slit in the dome at a distance of about 2.5 cms from it and as near to the cloud chamber as possible without touching it. A dark, insulating cover placed over the slits insured that only the scattered light passed through the slits and fell on the cell (PC_1). This slit-system allowed light from only a small scattering angle to fall on the photo-cell. The distance of the first slit from the centre of the cloud chamber was about 18 cms, the radius of the cloud chamber being 15 cms. Therefore, only a beam scattered through 2° passed through the slits. This meant that the scattering measured for a particular angle could be regarded as scattering due to an angle through 1″ on either side of the angle for which scattering was intended to be measured.

The authors are highly indebted to Professor B. B. Deshpande, of the R. R. College, Bombay, for suggesting the photo-cell and amplifier circuit and for taking keen interest in the work during its course.

ROYAL INSTITUTE OF SCIENCE,
BOMBAY

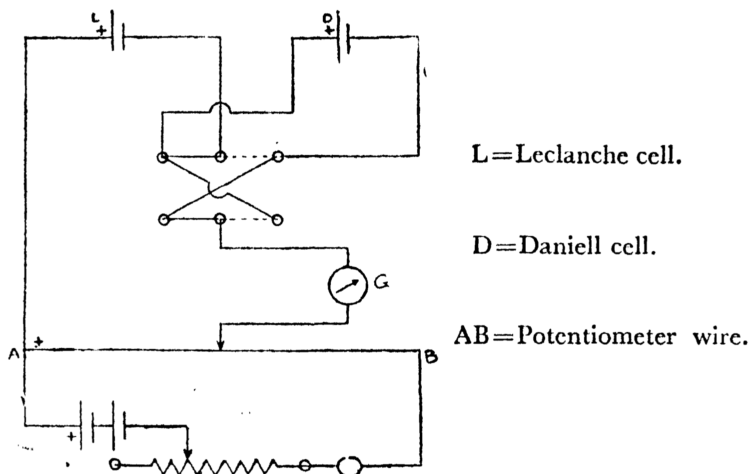
[*Received: August 23, 1943*]

Pohl Commutator Adapted for Sum and Difference of Two Cells

By

V. N. KELKAR

IN comparing the e.m.f's of two cells by the sum and difference method using a potentiometer, it is necessary to connect the cells (1) to help and (2) to oppose each other. This can be achieved very easily by a simple rockover of a Pohl commutator, so that a number of readings can be rapidly taken by changing the sensitivity of the potentiometer. The connections are shown in the following diagram :



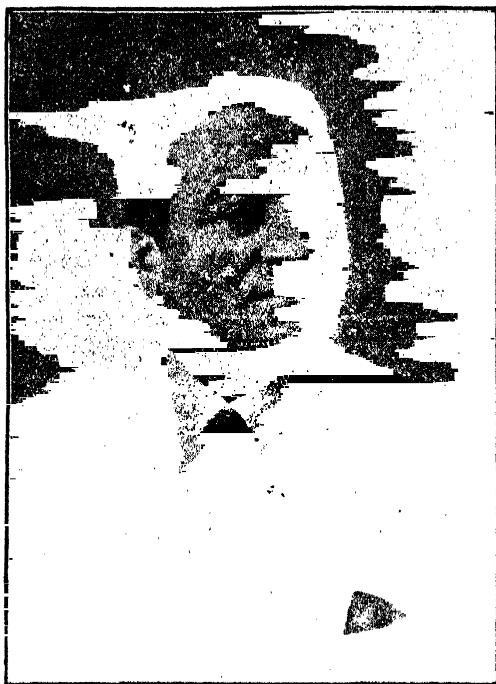
The solid connections between the mercury pools bring about the addition of e.m.f's $(e_1 + e_2)$ and the dotted connections give the difference $(e_1 - e_2)$.

It is thought that this note might be useful to those laboratories where the device suggested above has not been already adopted.

DEPARTMENT OF PHYSICS,
N. WADIA COLLEGE, POONA [*Received: July 2, 1943*]

Professor Sir Shantiswarup Bhatnagar, Kt., O.B.E., D.Sc., F.R.S., F.S.C.I. (Hon.), F.I.C., F. Inst. P., F.N.I.

THE honour which has been conferred on Professor Sir Shantiswarup Bhatnagar by his election to the Fellowship of the Royal Society, London, this year, must have brought great joy to his many friends and admirers, and particularly to his pupils. Indeed it must be a matter of pride to every Indian because this tribute paid to the scientific achievements of an eminent fellow-countryman raises the name of our country in the eyes of the world. The admission to this august academy of scientists is limited to men who have attained exceptional distinction by making substantial original contributions to some branch of science. The honour of this "Hall-mark of great distinction" has been conferred in previous years on Indian scientists who have made brilliant contributions to physical and meta-physical sciences. Prof. Bhatnagar is the first Indian chemist whose work in the realm of pure and applied chemistry has been recognised by the Royal Society for admission to the Fellowship. This is a clear indication of the international recognition



SIR SHANTISWARUP BHATNAGAR, KT., F.R.S.

(Courtesy of "Current Science")

of his invaluable work in chemical or physico-chemical subjects like surface tension and surface action, stability and reversal of emulsions, colloid phenomena, chemi-luminescence, photo-chemistry and specially magnetism and molecular structure, during the last twenty years.

Born at Bhera (Shahpur) in 1895, Shantiswarup lost his father at an early age and was brought up by his maternal grandfather. He received his early education at Dayal Singh High School and Forman Christian College, Lahore. After taking the M.Sc. Degree of the Punjab University in 1919, he proceeded as Dayal Singh Scholar to England, where he was attracted by the laboratories of Prof. F. G. Donnan, F.R.S., whose theory of membrane equilibria had made him world-famous. At the University College, London, Bhatnagar set out to investigate problems in the field of colloidal chemistry and soon achieved results of great consequence so as to deserve the award of a personal grant of £ 250 by the Privy Council, Department of Scientific and Industrial Research. In 1921, he was awarded the D.Sc. Degree of the London University on the merit of his work on emulsions and emulsification which now forms the major portion of a monograph by Dr. Clayton. Dr. Bhatnagar then went out to Berlin and Paris, and after working at the Kaiser Wilhelm Institute and at the Sorbonne for some time, he returned to India to take up the appointment of University Professor of Chemistry at the Benares Hindu University.

The facilities offered by the Benares Laboratories and the encouragement and appreciation which he received from Pandit Madan Mohan Malaviya, the then Vice-Chancellor of the University, gave a great scope to his untiring zeal for research, and students from all parts of India were attracted to him. But not long after, he had to transfer his activities to Lahore where he was invited by his *Alma Mater* to be the University Professor of Physical Chemistry and first Director of the newly created University Chemical Laboratories. Professor Bhatnagar utilised to the best advantage the facilities of these laboratories in investigating important problems of varied nature in theoretical chemistry and created a school of research in physical chemistry which is well-known in India and abroad, and in the words of the celebrated Professor F.G. Donnan can compare with any in the world. It was here that the work on magneto-chemistry for which he has specially distinguished himself was carried out, the Bhatnagar-Mathur Magnetic Balance, now manufactured by Messrs Adam Hilger, Ltd., was devised, and most of the problems embodied in his 140 publications were investigated.

While busy with his theoretical researches, Prof. Bhatnagar did not lose sight of the fact that the advancement of industries is the only solution of the progress of chemical knowledge in India. His ambitions for original contributions in industrial chemistry found an opportunity in the study of the problems which were presented to him by an Oil Company. The solution of the difficulties experienced with the drilling muds by the Company within a remarkably short period was his crowning success. Messrs Steel Bros. & Co. realised the advantages of their association with Prof. Bhatnagar and on his suggestion inaugurated a scheme of research on Petroleum Technology, under the auspices of the Punjab University, at a cost of Rs. 1½ lakhs for five years, which was later on extended to ten years, at a cost of Rs. 4 lakhs. Under this scheme, twelve Fellowships, named after various important personalities, were awarded for working under his guidance and the results obtained formed the material of several patents taken out by Messrs Steel Bros. Two of these investigations are the increase in the luminosity of kerosene oil and the prevention of the development of rancidity in paraffin wax and vegetable oils. Prof. Bhatnagar was also approached by several Indian industrialists who in their turn inaugurated research schemes and patented his processes.

The success which he achieved in this direction came to be known far and wide, and in 1940, when the Government of India inaugurated the Board of Scientific and Industrial Research, this most distinguished scientist of the Punjab was specially invited by His Excellency the Governor-General, to be its first Director. The ability with which he has administered and organised the working of the Board and the exceptional devotion with which he is striving to advance the Indian industries have won for him an appreciation and regard both from chemists and industrialists. During its short life of three years, the Board working along with its advisory bodies and special committees, has on its record an achievement unparalleled in history. Several of the schemes for the utilisation of the available resources of the country for the production of materials essential for the daily needs of the people, have been worked out and many of them have been put to large-scale production. Sir Shantiswarup has himself taken a keen

interest in several investigations, and from the laboratories of Alipore Test House, Calcutta, where he worked for some time, and later from the Laboratories of Scientific and Industrial Research, have emanated several processes which have been patented and are being industrially exploited. Air-foam for putting out fires, laminated boards, antigas cloth, luminous paints, artificial wool from seed cakes, plastics from Indian raw materials, self-sealing and unburstable tanks, are a few of the many items investigated under his guidance. The royalties personally earned by him on his several patents are made over for financing research workers working under the Board.

Professor Bhatnagar's work has been well recognised by the Government, Universities and Academic bodies. He was honoured with the title of O.B.E. in 1936 and knighted in 1941. He is a Fellow of several Universities and scientific societies. He has held the position of the President of the Indian Chemical Society, has presided over the deliberations of the Chemistry section of the Indian Science Congress on two occasions, the last one being at the Jubilee Session, and has recently been nominated an Honorary Member of the Society of Chemical Industry, a rare distinction conferred so far on only eleven scientists of the world. He is an Honorary Professor of Chemistry at the Benares Hindu University and the Universities of Punjab and Delhi.

Professor Bhatnagar is the author of "Principles and Application of Magneto-chemistry," which is the first book on the subject in English, and has been highly appreciated. He has also written a treatise on Electricity in Urdu. Specialisation has not narrowed Sir Shantiswarup's outlook. He is a man of wide culture, being very much interested in Urdu literature and poetry, and having himself composed several poems. The *Alma Mater* song of the Benares Hindu University is his composition.

Sir Shantiswarup possesses not only a fine brain and a great mind, but the kindest and sincerest of hearts. The older he grows, the younger he gets. We have few men like him in our midst. His distinguished personality and brilliant career, which have been thrown into relief by the recent honour conferred on him, are indeed a great credit to our country, and will surely be an increasing inspiration, as they have already been a very powerful influence, for others to follow in his footsteps in the field of scientific research.

MATA PRASAD

REVIEW

Some Aspects of Micellar and Molecular Action

A Review of the Presidential Address delivered to the Section of Chemistry, Indian Science Congress, 1943, by Dr. S. S. Joshi.

IN a small publication of 25 pages the author has condensed an account of a large amount of the work carried out by him and his co-workers for the last eighteen years at the Chemical Laboratories of the Benares Hindu University. The address deals mostly with the behaviour of colloidal systems undergoing coagulation, and of gases under electrodeless discharge, particularly when irradiated.

Although considerable work has been done on the coagulation of sols under varied circumstances for the last many years, still our knowledge of the mechanism of the protection and coagulation is far from complete. The author's work on the kinetics of slow coagulation of several sols by the study of the various properties, one of them being the refractive index which has not hitherto been employed for this purpose, has shown that the use of viscosity and transparency has a marked limitation as a measure of coagulation and that there is no *a priori* justification for the assumption that any one property of the coagulating system varies continuously with the changes in the number of the coagulated and the uncoagulated particles in a sol, which is responsible for the anomalies noticed in the application of Smoluchowski's theory. He has also brought to light the existence of a hitherto unrecognised factor—the "wall effect"—which plays an important role in determining the nature and the course of the coagulation process. Further, an extensive work from his laboratory has shown that the process of electrolytic and mutual coagulation and that brought about under the action of electrical oscillations, particularly in the slow region, as measured by the study of various properties of the coagulating systems, is zonal in character and the coagulation-time curves are discontinuous. The author has suggested a theory of coagulation of general applicability, which explains the observed results on rapid and slow coagulation as well as leads to various mathematical expressions theoretically or empirically derived by previous workers.

The author has given instances of several processes in which zonal effect is observed. He himself has observed it during the passage of electrodeless discharge in nitrogen peroxide and particularly in a mixture of nitrous oxide and hydrogen. The changes in pressure, current and the energy dissipated are periodic functions of time of exposure of the discharge.

In the end the author gives an account of a "New light effect"—a negative photo-effect, the suppression of conductivity—which has been observed with several gases when under electrical discharge they are irradiated to light of different wave-lengths, in tubes of different construction

and having walls coated with thin films of various substances. The study of this effect is being continued in the author's laboratory.

The author and his school of workers deserve to be congratulated for their contribution to the advancement of our knowledge of the mechanism of coagulation and for bringing to light phenomena which were hitherto unknown, in gases under electrical discharge.

MATA PRASAD

NOTES AND NEWS

Knowledge Alone Is Not Enough To Solve Our Problems

NOT a day passes when we do not read in the papers about deadlocks. A large number of problems in every department of life faces us and we find that they appear to be too difficult and complicated to be solved by the methods given to us by science. Deadlocks imply that there is not only a bankruptcy of thought but also of many spiritual qualities on the part of those who are responsible for the solution of these problems. The problems which defy solution are those of poverty, unemployment, wars, disunity among communities, nations, governments, faiths, races, rulers and the ruled, etc., etc.

The negative factors which prevent the resolution of the deadlocks are a lack of self-control, self-denial, self-sacrifice, broad vision, deep insight. The other positive disturbing factors are lust of greed, lust of power, lust of possessions, lust of prestige, etc. All these factors have contributed to the present chaos and conflict. These are due to fundamental maladjustments and these again are due to our ignoring the essential values of life. They are manifesting themselves in various unseemly and ugly forms such as exploitation, competition, profiteering, hoarding, aggressiveness, brute force, ruthless tyranny, regimentation of thought, etc.

The failure of the World Economic Conference held in London in 1933 when representatives of over fifty different countries were present may be cited in support of the statements made above. It was called in such high hopes to solve the difficult economic problems facing us, to do away with the paradox of "Poverty and Starvation in the midst of Plenty," to see that there is no longer any frustration of science, etc. But the Conference unfortunately broke up without doing anything for the simple reason that the representatives of each country wanted a lion's share for their own countries and were not prepared to sacrifice some of their sovereign rights and co-operate with one another. Lack of sacrifice and co-operation brought about the failure of the Conference ; there was no lack of brains.

The League of Nations may be cited as another example of failure for the same reasons, namely, lack of sincerity and spiritual strength on the part of the members constituting the League.

All of us are familiar with and have experienced the weakness of human nature in failing to make use of the new knowledge regarding nutrition. Knowledge of relationship between robust health and use of balanced diets is there, but owing to our false eating habits and not having sufficient spiritual strength to control the vagaries of a perverted palate, we are not able to make use of our knowledge, and instead of being guided by the latest findings of the science of dietetics, we are led by the dictates of our tongue and palate. Poverty of bodily health leads to poverty of intellect which becomes clouded on account of constant ill-health and is therefore not able to see things and events clearly and in their proper perspective; this also leads to bankruptcy of thought and the consequent inability to resolve the deadlocks.

To summarise : Science (knowledge, brains) alone is not enough to solve our present-day problems. Along with science we want spiritual strength and many spiritual qualities ; only then will the deadlocks confronting us begin to be solved one after the other. Ethical and spiritual progress has not kept pace with intellectual progress. Man has conquered the external world and obtained control over nature's forces, but has still to conquer the inner world and gain control over the forces of his inner nature. The bird of progress (civilisation) cannot fly with one wing (science), very strong, and another wing (ethics and spirituality), very weak. Both wings must be equally strong.

It is the duty of the University to see that there is provision in the curriculum provided by it for its alumni to develop equally from all sides, to develop the **whole** man, (heart and head and hands). Only then will the progress be smooth and not till then will the University be said to have fulfilled its *Dharma* as University (universality, for **Wholeness is Holiness, Nobility and Culture**).

D. D. Kanga

* * * * * *

We offer our hearty congratulations to Sir Shantiswarup Bhatnagar on his being elected to the Fellowship of the Royal Society of Great Britain. He is the eighth Indian to be the recipient of this unique honour. The first Indian F.R.S., was Srinivasa Ramanujan. The other recipients of this honour were—J. C. Bose, C. V. Raman, M. N. Saha, Birbal Sahani, K. S. Krishnan and J. H. Bhabha. None of these was a chemist. Sir Shantiswarup is the first Indian Chemist to join this distinguished band of Scientists. A short sketch of his life and work appears elsewhere in this number.

D. D. K.

LIST OF THESES

Table showing M. Sc., Ph. D. and D. Sc., theses in Physics, Chemistry and Geology (from October 1942 to September 30, 1943)

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate Worked	Name of the Institution
	M.Sc.		
	Physics		
Gokhale, S. D.	Studies in dielectric constants and dielectric polarisation : 1. Dipole moments of Glycol Derivatives ; 2. Polymarphism and Dielectric Constant	Professor S. D. Bhave	Sir P.
Jogalekar, S. Y.	Studies in Thermal Repulsion	Dr. L. A. Ramdas	I.M.D.
Tamhankar, R. V.	Distribution of Intensity of Light Scattered by a Cloud of Water Droplets	Principal G. R. Paranjpe	R.I.Sc.
	Chemistry		
Athavale, J. M.	Part I—Synthesis of 6-hydroxy-5-butyl-3-methyl-Coumarone. Part II—Synthesis of 2-propionyl-4-butyl resorcin by the extension of the Nidhone Process for the synthesis of 2-acyl-resorcins. Part III—Determination of the constitution of the Fries Migration product of 7-benzoyloxy-2-methylchromone	Professor D. B. Limaye	R.I.E.I.
Chhaya, B. N.	The Time of Setting of Inorganic Gels formed by the Interaction of Oppositely Charged Sols	Dr. Mata Prasad	R.I.Sc.
Desai, T. B.	Condensation of Ethyl Sodium Aceto-acetate with various anilide imidochlorides	Dr. R. C. Shah	R.I.Sc.
D'Souza, P. J. C.	I—Studies in 4: 6-diacetyl resorcin. II—Synthesis of 2:4-alkoxy-dialdehydo-benzenes. III—A critical review of Baker Juke's and Subrahmaniam's work on 7-methoxy-8-acetyl-2-methyl Chromone	Professor D. B. Limaye	R.I.E.I
Gaitonde, M. M.	Studies in Coumarins and Chromones (1. The Pechmann and Kostanecki Reactions with some γ-acylorcinols ; 2. Some Reactions of 4:7-dimethyl-5-hydroxy-coumarin and 6:7-dihydroxy 4-methyl-coumarin ; 3. Coumarins from Cyclic β-Ketonic Esters)	Professor V. V. Nadkarny	St. X.
Hattiangadi G. S.	Studies in some Inorgano-organic Gels in Non-Aqueous Media	Dr. Mata Prasad	R.I.Sc.
Jhaveri, A. T.	1. Studies in Sulphonephthaleins and 2. A new Synthesis of α-Naphthyl acetic acid	Dr. R. C. Shah	R.I.Sc
Lagawankar, J. D.	Studies in Vegetable Oils	Professor B. V. Bhide	Sir P.

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate Worked	Name of the Institution
Mehta, S. U.	Synthetical Anthelmintics; Synthesis of α-alkyl α p-methoxy phenyl butyrolactones	Dr. K. S. Nargund	G. C.
More, S. P.	Studies in the Reaction between Sodium Hypochlorite and Ammonium Chloride	Principal V. K. Bhagwat	R.N. R.
Nabar, S. V.	Some Reactions of Benzoxazole. Benziminazole and Benzthiazole Series	The *late* Professor R. N. Bhagwat and Professor V. V. Nadkarny	St. X.
Paranjpe, S. V.	1. Synthesis of 2-acetyl-4-butyl-resorcin by the Extension of the Nidhone Process for the Synthesis of 2-acyl-resorcins; 2. Effect of Methylation on the Course of Hydrolysis of 6-ethyl-4-methyl-unbelliferone and 8-acetyl-6-butyl-4-metyl-unbelliferone; 3. Synthesis of 4:2′-dimethyl-3′-acetyl-6-butyl-coumarin-7:8-γ-pyrone	Professor D. B. Limaye	R.I.E.I.
Patel, B. D.	An attempt of the Direct Synthesis of Substituted Cinnamic Acids and a Study of their Derivative and Related Compounds	Dr. K. V. Bokil	G. C.
Patel, D. K.	Studies on the Absorption of Iodine by Hydroxylamine Salts	Dr. R. K. Trivedi	B. C.
Patel, S. Z.	Investigations on Nitro-hydroxylaminates	Dr. K. G. Naik	B.C.
Patwardhan, S. V.	Effect of Different Electrolytes of the Absorption of Basic Dyestuffs by the Cotton Fibre	Professor V. V. Nadkarny	St. X.
Peermahomed F. R.	Recovery of Alumina and Titania from Bauxite Sludge	Professor V. V. Nadkarny	St. X.
Phadke, S. Y.	Part I—Carboxylation of 2-acetylresorcin. Part II—Studies on 7-hydroxy-4-methyl-coumarin-6-carboxylic acid. Part III—Synthesis of 2-butyryl-4-proplyresorcin by the extension of the Nidhone Process for the Syntheses of 2-acylresorcins. Part IV—Synthesis of 4:2′ dimethyl-3-ethyl-6-propyl-coumarin-7:8-γ-pyrone	Professor D. B. Limaye	R.I.E.I
Shah, R. C.	Studies in Heat Polymerisation of Fats	Professor B. V. Bhide	Sir P.
Shah, R. C.	Studies in Vegetable Oils and Fats	Professor V. V. Nadkarny	St. X.
Shah, R. H.	Condensation of Phenols with Ethyl Acetosuccinate	Dr. N. M. Shah	G. C.
Shintre, D. V.	Studies in Heterocyclic Compounds: Studies in the Acridine, the Thiazole and Pyrazole Series	Professor V. V. Nadkarny	St. X.

Name of the Candidate	Subject of the Thesis	Name of the Professor under whom the Candidate Worked	Name of the Institution
Shivjiani, B. H.	Commercial Preparation of Sachharin and Chloramine-T. from Toluene	Dr. R. C. Shah	R.I.Sc.
	Chem. Engineering		
Marathe, G. K.	Preparation of Cellulose from Banana Stalk	Professor K. Venkataraman	U.D.C.T.
	Ph. D.		
	Physics		
Manohar, M. D.	On the Nature of the Speech Sounds of Principal Indian Languages	Dr. S. K. Banerji	I.M.D.
	Chemistry		
Bavdekar, P. R.	Photoreduction of Ferric Chloride in presence of organic substances in aqueous and non-aqueous media	Dr. Mata Prasad	R.I.Sc.
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Guruswamy, S.	Study of the Optical Properties of Gels.	Dr. Mata Prasad	R.I.Sc.
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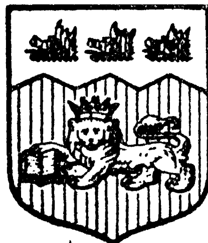
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PLACE OF NITROGENOUS FERTILISERS FOR DECCAN CROPS

Bajri (Pennisetum Typhoideum*)

By

PROFESSOR V. G. GOKHALE, L.AG., I.A.S., AND P. M. GAYAWALA, M.AG.

College of Agriculture, Poona

[Continued from Vol. XI (New Series), Part 5]

III. 1931-32

CHANGES INTRODUCED THIS YEAR

A STUDY of the results obtained in the years 1929-30 and 1930-31 indicated that the fertilisers applied at the rate of 10 pounds nitrogen per acre did not give any marked improvement in the yields. The 10 pounds nitrogen applied per acre in the previous years was therefore thought to be insufficient and the trial of 20 pounds nitrogen per acre was added since this year.

POSITION AND DESCRIPTION OF LAND SELECTED

The experiment was conducted on plots 1A to 8A the previous history of which is stated below :—

Year	Number of the plots	Name of the crop	Rain-fed or Irrigated	Amount of manure given per acre	Yield per acre in pounds
1928-29	1A to 4A 5A & 6A 7A & 8A	Bajri Cotton Garlic	Rain-fed Rain-fed Irrigated	16 carts F.Y.M. 10 carts F.Y.M. 10 carts F.Y.M.	1200 grain not available 2616 bulbs
1929-30	1A to 3A 4A 5A & 6A 7A & 8A	Groundnut Groundnut Groundnut Nilwa Jowar	Irrigated Rain-fed Irrigated Rain-fed	15 carts F.Y.M. 15 carts F.Y.M. *Nil* *Nil*	1817 pods 1832 pods 1334 pods 10619 fodder
1930 31	1A to 8A	Nilwa Jowar	Rain-fed	*Nil*	5155 fodder

Fig. 6 shows contours of levels as well as depths of soil upto murum layer and Tables III and IV give further description of soil in other respects.

In Table XIX are recorded moisture contents of soil in plot No. 5A.

*It is regretted that in the previous part of the article, appearing in the last issue of the Biological Sciences Number, this was inadvertently mentioned as 'Penceselum Typhoideum.'

Bajri crop—1931-32 and 1933-34

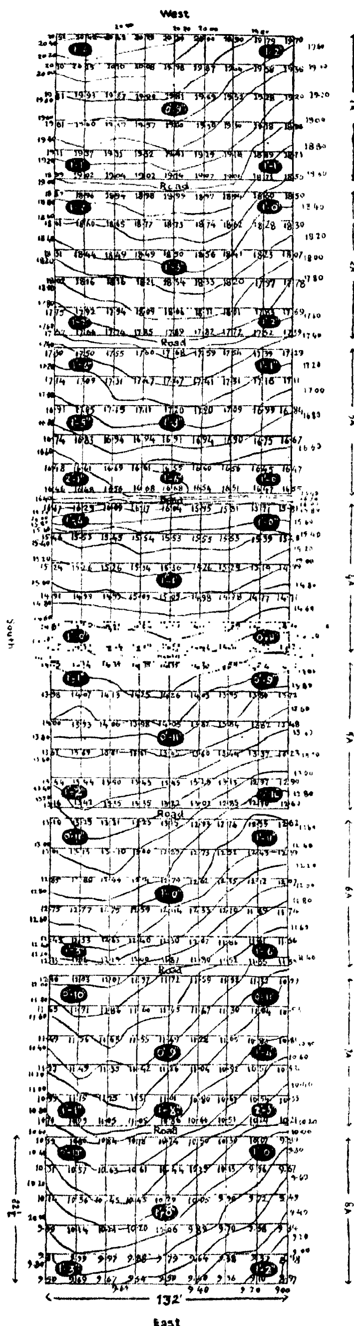


Fig. 6.—Contours of levels and depths of soil (as indicated by white figures in feet and inches on black spots) upto the murum layer in blocks 1A to 8A.

TABLE XIX

Percentages of moisture contents of soil on oven dry basis

Date	At 0′ to 6″ depth	At 6″ to 12″ depth	At 12″ to 18″ depth
21st July 1931	30.48	26.52	19.73
4th Aug. 1931	29.24	27.71	24.60
18th Aug. 1931	31.47	29.77	25.67
1st Sep. 1931	31.99	32.91	26.86
16th Sep. 1931	30.79	32.76	26.12
30th Sep. 1931	37.93	37.18	32.45
14th Oct. 1931	39.58	41.76	37.44

QUANTITY OF FERTILISERS

Quantities of fertilisers were such as to supply 10 pounds and 20 pounds of nitrogen in addition to $1\frac{1}{4}$ cart loads of farmyard manure per acre.

ARRANGEMENT OF PLOTS AND NUMBER OF REPLICATIONS

The actual situation of different treatments of 10 pounds and 20 pounds nitrogen in each of the eight replications provided is shown in Fig. 7.

Bajri—1931-32

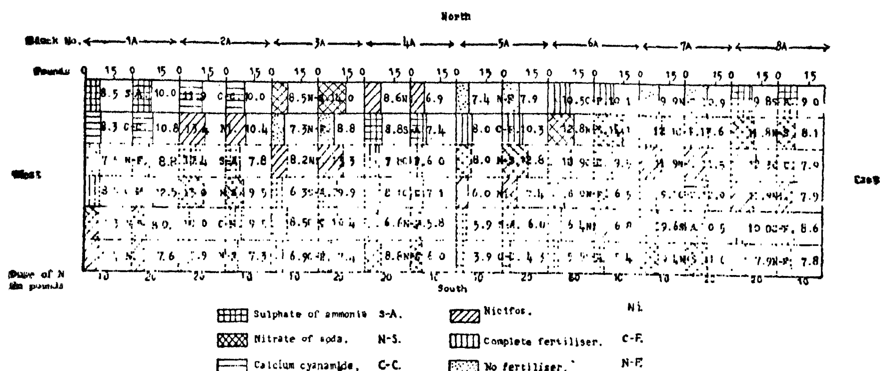


Fig. 7.—Situation of different treatments and yield per plot in pounds.

Cultural Details and Progress of the Crop

The preparatory tillage consisted of ploughing in the middle of April 1931 after the removal of the preceding crop to a depth of about seven inchess by a tractor followed by discing in the second and fourth weeks of June and blade harrowing in the middle of July. Farmyard manure was applied on 1st June and well mixed by a disc harrow. Sowing was done on 21st July 1931 by Schutte's improved drill with a seed rate of four pounds to an acre. The variety used was Economic Botanist's strain No. 59. Possibly on account of looseness of soil, the germination was not satisfactory and the stand of the crop varied considerably ranging from 10 to 85 per cent from plot to plot. Fertilisers were applied as a top dressing on 12th August by broadcasting between the crop lines and mixed thoroughly with the soil by weeding hooks. Later on, the crop was intercultivated early in September by a pair of Planet Junior hand hoes. Flowering commenced from 2nd September. On account of low and uneven stand, the crop looked patchy and uneven in growth in most of the plots. This year about 38 per cent of the earheads were either rendered entirely blank or were only partially filled with grain on account of heavy rains in the third week of September which was the time of pollination. It may be noted here that on account of the slightly sloping nature of the land almost all the plots suffered from washing to a small extent in west to east direction but no stagnation of water was noticed in any of the plots. The effect of the fertilisers on the standing crop began to be distinctly noticed from 9th September, *i.e.*, after about a month of their application. The crop passed a healthy life in all other respects and was harvested on 15th to 18th October 1931. Blocks containing plots of very low stand have been omitted and the results have been worked out only on five replications having fairly good stand.

Results

The details of the yield are set out in Fig. 7 and are worked out and presented separately under (A) for 10 pounds nitrogen and (B) for 20 pounds nitrogen, while under (C) the relative performance of both the quantities of nitrogen is compared.

(A) 10 POUNDS NITROGEN

TABLE XX

Yield of bajri grains in pounds per plot of 1.25 cents of an acre

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 8A	Mean of the five blocks	Percentage increase over check
Sulphate of ammonia	8.500	7.750	6.250	7.375	9.000	7.775	9.30
Nitrate of soda ..	7.250	9.500	8.500	6.000	8.125	7.875	10.71
Calcium cyanamide..	8.250	19.000	8.500	7.125	7.875	8.350	17.39
Nicifos ..	7.375	19.375	8.188	6.875	7.875	8.138	14.41
Complete fertiliser	8.500	9.500	6.875	6.000	8.625	7.900	11.6
No fertiliser ..	7.500	7.250	7.250	5.750	7.813	7.113	
Mean of the block ..	7.896	9.063	7.594	6.521	8.219	7.859	..

TABLE XXI

Yield of dry straw in pounds per plot of 1.25 cents of an acre

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 8A	Mean of the five blocks	Percentage increase over the check
Sulphate of ammonia	27	18	14	15	26	20.0	23.5
Nitrate of soda ..	21	28	20	20	29	23.6	45.7
Calcium cyanamide..	23	24	19	14	26	21.2	30.9
Nicifos ..	15	22	17	16	24	18.8	16.0
Complete fertiliser ..	22	23	17	13	29	20.8	28.4
No fertiliser ..	16	17	13	13	22	16.2	..
Mean of the block ..	21	22	17	15	26	20.1	..

With regard to the yield of grain, calcium cyanamide alone is significantly better than the no fertiliser check.

In the case of straw, sulphate of ammonia, nitrate of soda, calcium cyanamide and complete fertiliser are significantly better than the no fertiliser check and among the fertilisers themselves it is only the nitrate of soda which is significantly better than sulphate of ammonia and nicifos.

The percentage increases in straw are higher than those of grain, the divergence being greater in all other fertilisers than nicifos. The increases in straw have generally the same order of merit as grain with the exception of nitrate of soda and nicifos.

The ratio of the yield of straw to the yield of grain was worked out from the data recorded in Tables XX, and XXI and is presented in Table XXII.

TABLE XXII

Ratio of the yield of straw to the yield of grain

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 8A	Mean of the five blocks
Sulphate of ammonia ..	3.17	2.32	2.24	2.13	2.88	2.52
Nitrate of soda ..	2.89	2.94	2.35	3.33	3.56	3.01
Calcium cyanamide ..	2.78	2.40	2.23	1.96	3.30	2.53
Nicifos ..	2.03	2.12	2.07	2.32	3.04	2.31
Complete fertiliser ..	2.57	2.42	2.47	2.16	3.36	2.59
No fertiliser ..	2.13	2.34	1.79	2.26	2.82	2.26
Mean of each block ..	2.60	2.42	2.19	2.36	3.16	2.54

From the above data it is seen that the fertilisers have not been able to increase the yield of grain commensurately with the vegetative matter.

The capacity of vegetative matter to produce grain is the least with nitrate of soda and the highest with nicifos and no fertiliser.

Judging from periodical observations on the standing crop, the treat ments showed distinct superiority over check in the number of replication stated against each on dates specified below.

Treatment	Cases of superiority over check out of five on dates		
	24-8-31	9-9-31	23-9-31
Sulphate of ammonia ..	2	4	4
Nitrate of soda ..	2	4	4
Calcium cyanamide ..	3	4	4
Nicifos ..	1	4	5
Complete fertiliser ..	1	4	4

Most of the plots which appeared superior to check during the growing period have also given superior final yields of grain and straw.

INFLUENCE OF FERTILISERS ON THE QUALITY OF BAJRI GRAINS

The differences in quality were very slight and not enough to affect the market value. The different treatments stood in the order of (1) nicifos, (2) nitrate of soda and no fertiliser, (3) calcium cyanamide and sulphate of ammonia and (4) complete fertiliser.

The food-value analysis of the representative samples of *bajri* grain are given below :—

Food constituents	Sulphate of ammonia	Nitrate of soda	Calcium cyana-mide	Nicifos	Complete fertil-iser	No fertil-iser
Moisture ..	5.40	7.44	7.31	7.20	7.28	5.10
Ether extract ..	4.90	3.83	4.35	4.31	3.87	3.10
Albuminoids* ..	9.06	7.81	7.75	7.94	7.44	7.88
Digestible carbo-hydrates ..	78.54	78.32	78.46	78.35	79.05	82.27
Woody fibre ..	0.50	0.91	0.45	0.43	0.80	0.45
Ash** ..	1.60	1.69	1.68	1.77	1.56	1.20
Containing—						
*Nitrogen ..	1.45	1.25	1.24	1.27	1.19	1.26
**Sand ..	0.07	0.06	0.18	0.05	0.08	0.07

Albuminoids appear to vary generally in some inverse proportion with the yield (Table XXIII), that with sulphate of ammonia being much more than its due share. The woody fibre is the largest with nitrate of soda and the least with nicifos. The ash content is the highest with nicifos and the lowest with no fertiliser.

With a view to study as to how the different fertilisers act and the reasons of differences in their behaviour, data were collected in regard to the soil and the various phases of plant growth.

The means of different block yields of grain afford a good comparison of the effect of soil. These vary from 6.521 to 9.063 giving thereby a range of variation of −17.0 to +15.3 per cent from the general mean. To all appearances the colour, texture and levels of soil in different blocks (Fig. 8 and Table 7) do not show any marked variations which can explain the differences in the different block yields. Different degrees of looseness of seed-bed were however observed to have given strikingly different germination and stand.

A study of the number of plants per plot as recorded in Table XXVI shows :

(1) Calcium cyanamide has given the highest mean and complete fertiliser the lowest.

(2) The differences in the number of plants from block to block appear to have been caused by the varying germinating capacity of the soil as noted before.

(3) Other conditions remaining the same, variation in the number of plants has some direct influence on the yield of grain per unit area.

TABLE XXIII

Number of plants per plot of 1.25 cents of an acre

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 8A	Mean of the five blocks
Sulphate of ammonia ..	632	745	532	393	521	565
Nitrate of soda ..	611	637	569	410	585	562
Calcium cyanamide ..	633	749	552	432	597	593
Nicifos ..	620	777	656	317	551	584
Complete fertiliser ..	609	699	533	431	491	553
No fertiliser ..	777	657	493	350	563	568
Mean of each block ..	647	711	556	389	551	571

Other phases studied are tillering and filling of earheads as indicated by data in Tables XXIV and XXV.

TABLE XXIV

Number of earheads of different classes per plot of 1.25 cents of an acre

Number of the block	Class of the earheads	Sulphate of ammonia	Nitrate of soda	Calcium cyanamide	Nicifos	Complete fertiliser	No fertiliser	Mean of each block
1A	Filled	512	565	544	670	627	703	604
	Blank	400	180	300	160	250	360	275
2A	Filled	610	708	622	776	727	619	677
	Blank	385	360	355	237	268	315	320
3A	Filled	473	542	522	540	512	454	507
	Blank	404	275	270	305	290	210	309
4A	Filled	464	360	442	394	415	355	405
	Blank	175	308	235	257	258	257	248
8A	Filled	418	410	444	420	430	553	446
	Blank	488	620	533	556	585	570	559
Mean of 5 blocks	Filled	495	517	515	560	542	537	544
	Blank	370	349	339	303	330	342	334
Percentage of total number of earheads	Filled	57	60	60	65	62	61	
	Blank	43	40	40	35	38	39	

TABLE XXV

Number of earheads per plant or tillering

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 8A	Mean of the five blocks
Sulphate of ammonia ..	1.44	1.34	1.65	1.62	1.74	1.56
Nitrate of soda ..	1.22	1.70	1.44	1.63	1.76	1.55
Calcium cyanamide ..	1.33	1.30	1.43	1.57	1.64	1.45
Nicifos ..	1.34	1.30	1.29	2.05	1.77	1.55
Complete fertiliser ..	1.44	1.42	1.50	1.56	2.07	1.60
No fertiliser ..	1.37	1.42	1.35	1.75	1.99	1.58
Mean of each block ..	1.36	1.41	1.44	1.70	1.83	1.55

A tendency of a larger number of plants being associated with less tillering is noticeable.

Nicifos has given the largest and sulphate of ammonia the least proportion of filled earheads.

One important factor which contributes to the yield of grain is also the weight per earhead. A study of this from observations as recorded in Table XXVI reveals :

(1) The weight per earhead is more or less in the inverse proportion to the number of earheads or in other words the number of bearing plants.

(2) The fertilisers have been able to increase the weight per earhead over the one in compensation for the number of earheads per unit area, sulphate of ammonia and calcium cyanamide being better than others in this respect.

TABLE XXVI

Average weight per fully filled earhead in tolas

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 8A	Mean of the five blocks
Sulphate of ammonia ..	0.79	0.71	0.70	0.88	0.99	0.81
Nitrate of soda ..	0.76	0.64	0.80	0.79	0.79	0.76
Calcium cyanamide ..	0.72	0.79	0.79	0.79	0.95	0.81
Nicifos ..	0.59	0.66	0.77	0.93	0.80	0.75
Complete fertiliser ..	0.67	0.61	0.77	0.89	0.79	0.75
No fertiliser ..	0.54	0.58	0.81	0.85	0.65	0.69
Mean of each block ..	0.68	0.67	0.77	0.86	0.83	0.76

(B) 20 POUNDS NITROGEN

TABLE XXVII

Yield of bajri grains in pounds per plot of 1.25 cents of an acre

Treatment	Block 2A	Block 3A	Block 4A	Block 7A	Block 8A	Mean of the five blocks	Percentage increase over the check
Sulphate of ammonia	10.375	9.875	8.750	10.500	9.750	9.850	23.12
Nitrate of soda ..	13.000	14.000	8.750	11.000	11.750	11.700	46.25
Calcium cyanamide	11.875	10.375	8.125	12.000	12.250	10.925	36.56
Nicifos ..	13.375	13.250	8.563	11.500	11.875	11.713	46.41
Complete fertiliser	10.000	7.375	7.750	13.625	10.000	9.750	21.88
No fertiliser ..	5.875	8.750	6.625	10.875	7.875	8.000	..
Mean of the block	10.750	10.604	8.094	11.583	10.583	10.323	..

TABLE XXVIII

Yield of dry straw in pounds per plot of 1.25 cents of an acre

Treatment	Block 2A	Block 3A	Block 4A	Block 7A	Block 8A	Mean of the five blocks	Percentage increase over the check
Sulphate of ammonia	24	21	18	24	28	23.0	35.3
Nitrate of soda ..	31	33	30	33	27	30.8	81.2
Calcium cyanamide ..	30	27	18	29	34	27.6	62.4
Nicifos ..	29	28	21	25	30	26.6	56.5
Complete fertiliser ..	22	23	19	28	26	23.6	38.8
No fertiliser ..	16	19	15	14	21	17.0	....
Mean of the block ..	25	25	20	26	28	24.8	....

With regard to the yield of grain, nitrate of soda, calcium cyanamide and nicifos are significantly better than the no fertiliser check and among the fertilisers themselves, nicifos is significantly better than complete fertiliser.

In the case of straw, all the fertilisers have yielded significantly better than the no fertiliser check and among the fertilisers themselves nitrate of soda and calcium cyanamide are significantly better than complete fertiliser or sulphate of ammonia.

The percentage increases in straw are generally higher than those of grain. The increases in straw have generally the same order of merit as grain with the exception of nicifos.

The ratio of the yield of straw to the yield of grain was worked out from the data recorded in Tables XXVII and XXVIII and is presented in Table XXIX.

TABLE XXIX

Ratio of the yield of straw to the yield of grain

Treatment	Block 2A	Block 3A	Block 4A	Block 7A	Block 8A	Mean of the five blocks
Sulphate of ammonia ..	2.31	2.12	2.05	2.28	2.87	2.33
Nitrate of soda ..	2.38	2.36	3.42	3.00	2.29	2.69
Calcium cyanamide ..	2.52	2.60	2.21	2.41	2.77	2.50
Nicifos ..	2.16	2.11	2.45	2.17	2.52	2.28
Complete fertiliser ..	2.20	3.11	2.45	2.05	2.60	2.48
No fertiliser ..	2.75	2.17	2.26	1.28	2.66	2.22
Mean of each block ..	2.39	2.41	2.47	2.20	2.62	2.42

From the above data it is seen that the fertilisers have not been able to increase the yield of grain commensurately with the increase in the yield of vegetative matter.

The capacity of vegetative matter to produce grain is the least with nitrate of soda and the highest with nicifos and no fertiliser.

Judging from periodical observations on the standing crop, the treatments showed distinct superiority over check in the number of replications stated against each on dates specified below :—

Treatment	Cases of superiority over check out of five on dates		
	24-8-31	9-9-31	23-9-31
Sulphate of ammonia ..	2	4	5
Nitrate of soda ..	4	5	5
Calcium cyanamide ..	2	5	5
Nicifos ..	2	5	5
Complete fertiliser ..	..	4	4

Most of the plots which appeared superior to check during the growing period have also given superior final yields of grain and straw.

Influence of Fertilisers on the Quality of Bajri Grains

The differences in quality were very slight and not enough to affect the market value. The different treatments stood in the order of (1) no fertiliser and calcium cyanamide, (2) sulphate of ammonia, nicifos and nitrate of soda and (3) complete fertiliser.

The food-value analysis of the representative samples of the *bajri* grains are given below :—

Food constituents in percentage	Sulphate of ammonia	Nitrate of soda	Calcium cyanamide	Nicifos	Complete fertiliser	No fertiliser
Moisture ..	5.60	7.24	7.32	7.53	7.46	4.85
Ether extract ..	2.25	4.00	4.71	4.20	4.76	5.20
Albuminoids* ..	8.38	7.37	8.63	8.12	7.94	7.88
Digestible carbohydrates ..	82.12	79.37	77.20	77.68	77.45	80.12
Woody fibre ..	0.75	0.70	0.44	0.76	0.84	0.25
Ash** ..	0.90	1.32	1.70	1.71	1.79	1.70
Containing—						
*Nitrogen ..	1.34	1.18	1.38	1.30	1.27	1.26
**Sand ..	0.07	0.05	0.11	0.08	0.03	0.12

Albuminoids appear to vary generally in some inverse proportion with the yield (Table XXVII) with the exception of complete fertiliser, that with sulphate of ammonia and calcium cyanamide being much more than their due share.

With a view to study as to how the different fertilisers act and the reasons of differences in their behaviour, data were collected in regard to the soil and the various phases of plant growth.

The means of different block yields of grain afford a good comparison of the effect of soil. These vary from 8.094 to 11.583 giving thereby a range of variation of −27.5 to +15.6 per cent from the general mean. Observation with regard to the influence of soil is about the same as noted under the 10 pounds dose.

A study of the number of plants per plot as recorded in Table XXX shows:

(1) Complete fertiliser has given the highest mean and sulphate of ammonia the lowest.

(2) The differences in the number of plants from block to block appear to have been caused by the varying germinating capacity of the soil as noted before.

(3). Yield does not appear to show any relation with number of plants per unit area except a very small number of plants giving the lowest yield.

TABLE XXX

Number of plants per plot of 1.25 cents of an acre

Treatment	Block 2A	Block 3A	Block 4A	Block 7A	Block 8A	Mean of the five blocks
Sulphate of ammonia ..	874	386	380	590	542	554
Nitrate of soda ..	815	506	404	574	725	605
Calcium cyanamide ..	752	344	415	673	603	557
Nicifos ..	917	501	365	730	635	630
Complete fertiliser ..	1031	457	373	776	526	633
No fertiliser ..	997	460	295	648	624	605
Mean of each block ..	898	412	372	665	609	597

Other phases studied are tillering and filling of earheads as indicated by data in Tables XXXI and XXXII.

TABLE XXXI

Number of earheads of different classes per plot of 1.25 cents of an acre

Number of the block	Class of the earhead	Sulphate of ammonia	Nitrate of soda	Calcium cyanamide	Nicifos	Complete fertiliser	No fertiliser	Mean of each block
2A	Filled	990	880	792	687	882	874	851
	Blank	315	406	365	315	225	250	313
3A	Filled	656	721	465	845	566	610	634
	Blank	208	279	220	310	319	175	252
4A	Filled	520	537	529	510	500	419	503
	Blank	212	360	284	310	288	265	287
7A	Filled	780	590	526	851	846	775	728
	Blank	485	485	502	352	472	300	433
8A	Filled	545	612	680	495	670	523	588
	Blank	362	620	415	680	400	741	536
Mean of 5 blocks	Filled	698	668	598	678	681	640	661
	Blank	316	430	357	393	341	346	364
Percentage of total	Filled	69	61	62	63	67	65	
	Blank	31	39	38	37	33	35	

TABLE XXXII

Number of earheads per plant or tillering

Treatment	Block 2A	Block 3A	Block 4A	Block 7A	Block 8A	Mean of the five blocks
Sulphate of ammonia ..	1.49	2.23	1.92	2.14	1.67	1.89
Nitrate of soda ..	1.57	1.97	2.22	1.87	1.69	1.86
Calcium cyanamide ..	1.53	1.99	1.95	1.52	1.81	1.76
Nicifos ..	1.09	2.30	2.24	1.64	1.85	1.82
Complete fertiliser ..	1.07	1.80	2.11	1.69	2.03	1.74
No fertiliser ..	1.12	1.70	2.31	1.65	2.02	1.76
Mean of each block ..	1.31	2.00	2.13	1.75	1.85	1.81

A tendency of a larger number of plants being associated with less tillering is clearly noticeable.

Sulphate of ammonia has given the largest and nitrate of soda the least proportion of filled earheads.

One important factor which contributes to the yield of grain is also the weight per earhead. A study of this from observations as recorded in Table XXXIII reveals :

(1) The weight per earhead is more or less in the inverse proportion to the number of earheads or in other words the number of bearing plants.

(2) The fertilisers have been able to increase the weight per earhead over the one in compensation for the number of earheads per unit area, nitrate of soda, calcium cyanamide and nicifos being better than others in this respect.

TABLE XXXIII

Average weight per fully filled earhead in tolas

Treatment	Block 2A	Block 3A	Block 4A	Block 7A	Block 8A	Mean of the five blocks
Sulphate of ammonia ..	0.57	0.79	0.92	0.71	0.97	0.75
Nitrate of soda ..	0.72	0.96	0.84	0.90	0.96	0.88
Calcium cyanamide ..	0.78	1.14	0.75	0.95	0.90	0.90
Nicifos ..	0.92	0.78	0.94	0.70	0.98	0.86
Complete fertiliser ..	0.59	0.86	0.88	0.80	0.72	0.77
No fertiliser ..	0.39	0.75	0.89	0.75	0.64	0.68
Mean of each block ..	0.66	0.88	0.87	0.80	0.86	0.81

(C) A COMPARATIVE STUDY OF 10 AND 20 POUNDS NITROGEN DOSES

The average yield with 20 pounds dose is 826 pounds grain and 1984 pounds straw as against 629 pounds grain and 1608 pounds straw with 10 pounds. As the plots under 10 and 20 pounds doses of each of the treatments were situated in pairs side by side (Fig. 9), the results of the two doses were interpreted in pairs by Student's method. The pairs of treatments having unusually low stand have been discarded, the number of replications actually taken into consideration thus being as stated in Table XXXIV.

TABLE XXXIV

Comparison of grain yields from 10 and 20 pounds nitrogen doses

Treatment	Number of replications taken into account for statistical interpretation	Value of 'Z' according to Student's method		Percentage increase in the mean yield of 20 N. over 10 N.
		To be taken as a basis of comparison	Actually obtained	
Sulphate of ammonia	6 replications comprising blocks 1A to 4A, 7A and 8A	1.10	1.76	22
Nitrate of soda	7 replications comprising blocks 2A to 8A	0.96	1.38	32
Calcium cyanamide	6 replications comprising blocks 1A to 4A, 6A and 8A	1.10	1.99	25
Nicifos	5 replications comprising blocks 2A, 3A, 4A, 7A, and 8A	1.30	1.42	30
Complete fertiliser	All the 8 replications comprising blocks 1A to 8A	0.85	1.36	18

It is clear that the increases in the yield of grain contributed by the 20 pounds over the corresponding 10 pounds nitrogen dose, amount to substantial figures ranging from 18 to 32 per cent in different treatments and that the differences are in all cases statistically significant.

20 pounds dose has also given an improvement in the number of earheads per plant as well as in the average weight per earhead as can be seen from the following figures.

Nitrogen dose in pounds per acre	Number of earheads per plant	Weight per filled earhead in tolas
20	1.81	0.81
10	1.55	0.76

Regarding the grain producing capacity of a unit amount of straw, it is to be noticed that it is higher with the higher dose and markedly so with nitrate of soda.

The differences in the number of plants per unit area in the two doses are not quite certain.

From periodical observations on the standing crop, it was noticed that the treatments under the 20 pounds showed distinct improvements in about half the number of cases over the corresponding treatments under the 10 pounds nitrogen dose.

As regards quality, there is not much difference between the two doses. The differences in food-value are not large and consistent in the case of different treatments under the 10 and 20 pounds nitrogen doses.

IV. 1932—33

Changes Introduced This Year

This year 20 pounds nitrogen dose was repeated for further verification, 10 pounds nitrogen dose being discontinued.

Position and Description of the Land Selected

The experiment was conducted on plots 1B to 8B. These are the same plots on which this experiment was conducted in the year 1930-31. The previous history, the surface levels and depths of the soils of these plots upto the year 1929-30 are given under the year 1930-31 (vide page 21 Jour. Univ. Bom., Vol XI, Part 5, Biological Sciences Section) and after the bajri crop of the year 1930-31 of the present experiment was harvested, all these plots had Spanish peanut groundnut crop in the monsoon and gram in the winter season of 1931-32. Both of them were grown as rain-fed crops and were not manured. The groundnut crop yielded 1505 pounds pods while the gram crop yielded 264 pounds of grain per acre.

In Table XXXV are recorded moisture contents of soil in plot No. 5B.

Table XXXV

Percentages of moisture contents of soil on oven dry basis

Date	At 0″ to 6″ depth	At 6″ to 12″ depth	At 12″ to 18″ depth
12th July 1932 ..	30.28	29.14	26.87
26th July 1932 ..	34.88	30.89	30.79
9th August 1932 ..	33.98	31.62	30.62
23rd August 1932 ..	33.05	30.72	30.17
6th September 1932 ..	34.12	32.55	30.75
20th September 1932 ..	25.48	28.98	25.10
4th October 1932 ..	23.60	27.58	24.72

Quantity of Fertilisers

Quantities of fertilisers were such as to supply 20 pounds of nitrogen in addition to 1¼ cart loads of farmyard manure per acre.

Arrangement of Plots and Number of Replications

The actual situation of different treatments in each of the eight replications provided is shown in Fig. 8

Bajri—1932-33

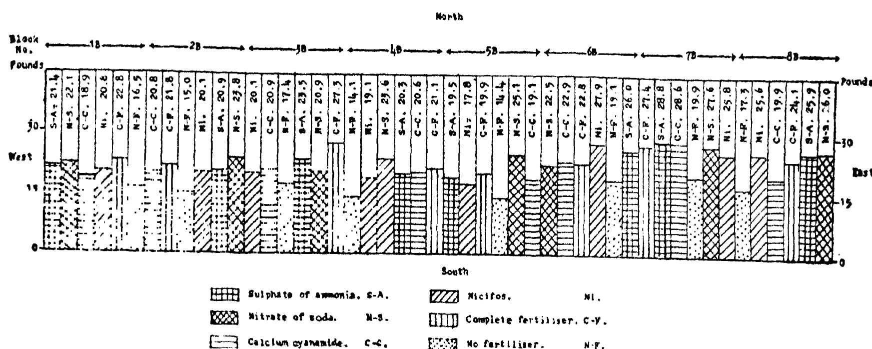


Fig. 8.—Situation of different treatments and yield per plot in pounds.

Cultural Details and Progress of the Crop

The preparatory tillage consisted of ploughing in November 1931 along with the sowing of the previous crop of gram to a depth of about seven inches followed by discing in the last week of May 1932 and blade harrowing in the last week of May and in the second and the third weeks of June. Farmyard manure was applied on 21st May 1932 and well mixed by a disc harrow. Sowing was done on 12th July 1932 with a country drill with a seed rate of 9¼ pounds per acre. The seed rate was purposely kept so high to compensate with as low as 55 per cent germination obtained in the trial pot. The variety used was Economic Botanist's strain No. 54. The germination had rather thickly come up on account of the high initial seed rate and therefore the crop was thinned soon after the germination was completed. Fertilisers were applied as a top dressing on 11th August by broadcasting between the crop lines and mixed thoroughly with the soil by a pair of entire bladed Deccan hoes. Later on, the crop was intercultivated once by a pair of the same entire bladed Deccan hoes on 20th August. Flowering commenced from 21st August. This year probably on account of continuous rains during the early growing period of the crop, the height of the crop did not exceed 5 feet which however saved the crop from being lodged down in heavy rains. About 30 per cent of the earheads were either rendered entirely blank or were only partially filled with grains on account of heavy rains in the first week of September which was the time of pollination. It may be noted here that on account of the small bunds made around each treatment plot on all the four sides, the washing of the soil had not taken place from plot to plot during the days of heavy rains as had occurred in these plots in the year 1930-31. The effect of fertilisers on the standing crop began to be distinctly noticed from 25th August, *i.e.*, two weeks after their application. The crop on the whole passed a healthy life in all other respects and was harvested on 12th to 14th October 1932.

TABLE XXXVI

Yield of bajri grains in pounds per plot of 2.5 cents of an acre

Treatment	Block 1B	Block 2B	Block 3B	Block 4B	Block 5B	Block 6B	Block 7B	Block 8B	Mean of the eight blocks	Percentage increase over the check
Sulphate of ammonia ..	21.375	20.875	23.500	20.250	19.500	26.000	28.750	25.875	23.266	39.3
Nitrate of soda ..	22.125	23.750	20.875	23.625	25.125	22.500	27.625	26.000	23.953	43.4
Calcium cyanamide ..	18.875	20.750	20.875	20.625	19.125	22.875	28.625	19.875	21.453	28.4
Nicifos ..	20.750	20.125	20.125	19.125	17.750	27.875	25.750	25.625	22.141	32.6
Complete fertiliser ..	22.750	21.750	27.250	21.125	19.875	22.750	27.375	24.125	23.375	40.0
No fertiliser ..	16.500	15.000	17.375	14.125	14.375	19.125	19.875	17.250	16.703	..
Mean of the block ..	20.396	20.375	21.667	19.813	19.292	23.521	26.333	23.125	21.815	..

TABLE XXXVII

Yield of dry straw in pounds per plot of 2.5 cents of an acre

Treatment	Block 1B	Block 2B	Block 3B	Block 4B	Block 5B	Block 6B	Block 7B	Block 8B	Mean of the eight blocks	Percentage increase over the check
Sulphate of ammonia ..	34	29	33	29	24	37	42	38	33	37.5
Nitrate of soda ..	36	35	34	34	40	34	43	42	37	54.2
Calcium cyanamide ..	29	29	28	28	28	28	42	29	30	25.0
Nicifos ..	29	28	28	28	23	36	33	34	30	25.0
Complete fertiliser ..	30	30	29	31	26	26	36	35	30	25.0
No fertiliser ..	25	22	25	18	19	29	26	26	24	..
Mean of the block ..	31	29	30	28	27	32	37	34	31	..

RESULTS

The details of the yield are set out in Fig. 8 and in Tables XXXVI and XXXVII.

Every fertiliser is significantly better than the no fertiliser check, both in respect of grain and straw. With regard to the yield of grain, among the fertilisers themselves, nitrate of soda or complete fertiliser has yielded significantly better than calcium cyanamide. In respect of the yield of straw, nitrate of soda is significantly better than every other fertiliser, and sulphate of ammonia is significantly better than calcium cyanamide, nicifos and complete fertiliser.

The percentage increases in straw are generally smaller than those of grain with the exception of nitrate of soda. The increases in straw have generally the same order of merit as grain.

The ratio of the yield of straw to the yield of grains was worked out from the data recorded in Tables XXXVI and XXXVII and is presented in Table XXXVIII.

TABLE XXXVIII

Ratio of the yield of straw to the yield of grain

Treatment	Block 1B	Block 2B	Block 3B	Block 4B	Block 5B	Block 6B	Block 7B	Block 8B	Mean of 8 blocks
Sulphate of ammonia	1.59	1.38	1.40	1.43	1.23	1.42	1.46	1.46	1.42
Nitrate of soda ..	1.62	1.47	1.62	1.43	1.59	1.51	1.56	1.61	1.55
Calcium cyanamide	1.53	1.39	1.34	1.35	1.46	1.22	1.46	1.45	1.40
Nicifos ..	1.39	1.39	1.39	1.46	1.29	1.29	1.28	1.32	1.35
Complete fertiliser ..	1.32	1.38	1.06	1.46	1.30	1.14	1.31	1.45	1.30
No fertiliser ..	1.51	1.46	1.43	1.27	1.32	1.51	1.30	1.50	1.41
Mean of each block	1.47	1.41	1.37	1.40	1.37	1.35	1.40	1.47	1.41

This year the capacity of vegetative matter to produce grain is larger with calcium cyanamide, nicifos and complete fertiliser and the same or less with the rest.

Judging from periodical observations on the standing crop, the treatments show distinct superiority over the check in the number of replications stated against each on dates specified below :—

Treatment	Cases of superiority over check out of eight on dates		
	25-8-32	7-9-32	21-9 32
Sulphate of ammonia ..	8	8	8
Nitrate of soda ..	7	8	8
Calcium cyanamide ..	7	8	8
Nicifos ..	7	8	8
Complete fertiliser ..	7	8	8

Most of the treated plots which appeared superior to check during the growing period have also given superior final yields.

INFLUENCE OF FERTILISERS ON THE QUALITY OF BAJRI GRAINS

The differences in quality were very slight and not enough to affect the market value. The different treatments stood in the order of (1) nitrate of soda and calcium cyanamide, (2) nicifos sulphate of ammonia, complete fertiliser and (3) no fertiliser.

The food-value analysis of the representative samples of *bajri* grains are given below :—

Food constituents in percentage	Sulphate of ammonia	Nitrate of soda	Calcium cyana-mide	Nicifos	Complete fer li-ser	No fertili-ser
Moisture ..	8.60	8.65	7.90	7.90	7.90	8.20
Ether extract ..	6.00	6.00	5.90	5.95	5.90	6.00
Albuminoids* ..	8.88	9.00	8.81	9.06	8.56	8.44
Digestible carbohy-drates ..	73.87	73.00	74.69	74.41	74.79	74.51
Woody fibre ..	0.75	0.70	0.80	0.60	0.75	0.80
Ash** ..	1.90	2.65	1.90	2.08	2.10	2.05
Containing—						
*Nitrogen ..	1.42	1.44	1.41	1.45	1.37	1.35
**Sand ..	0.20	0.70	0.25	0.30	0.30	0.30

Albuminoids in the fertiliser treated plots are more than in the untreated one, that in complete fertiliser being the lowest. The woody fibre is the least in nicifos. Ash content is the highest with nitrate of soda.

With a view to study as to how the different fertilisers act and the reasons of differences in their behaviour, data were collected in regard to the soil and the various phases of plant growth.

The means of the different block yields of grain afford a good comparison of the effect of soil. These vary from 19.292 to 26.233, the range of variation being −11.9 to +21.2 per cent from the general mean. An examination of individual block variation reveals both in the case of grain and straw that the highest block yields are associated with finer texture and somewhat darker colour (blocks 7B and 6B), while the lowest yields with coarser texture and light brown colour (block 5B). Soils intermediate in texture and colour (blocks 1B, 2B, 3B, 4B and 8B) stand intermediate in yields. Depths greater than eleven inches do not appear to influence the yields (Fig. 6) with the same texture and colour. Different fertilities of soil have given nearly the same ratio of straw to grain. It is not possible to interpret the influence of differences in slopes, as they are mixed with those of many other factors.

A study of the number of plants per plot as recorded in Table XXXIX shows :

(1) Other conditions remaining the same, the variations in the number of plants have not caused any consistent difference in the yield per unit area.

(2) The stand of the crop in the case of fertilisers is about 10 per cent better than that in no fertiliser, the different fertilisers being equal within themselves. No such difference can be associated in respect of fertility of blocks.

TABLE XXXIX

Number of plants per plot of 2.5 cents of an acre

Treatment	Block 1B	Block 2B	Block 3B	Block 4B	Block 5B	Block 6B	Block 7B	Block 8B	Mean of 8 blocks
Sulphate of ammonia	2558	2105	2320	2081	2336	1738	2330	2117	2198
Nitrate of soda ..	2592	2364	2340	1939	2429	2035	2127	1776	2200
Calcium cyanamide	2339	2382	2181	1954	2104	2244	1943	1908	2132
Nicifos ..	2307	2299	2450	2167	2010	1963	2087	2240	2190
Complete fertiliser	2301	2552	2026	2128	2363	1979	2088	2024	2183
No fertiliser ..	2233	1944	2248	1973	2013	1723	2072	1815	2003
Mean of each block	2388	2274	2261	2040	2209	1947	2108	1980	2151

Other phases studied are tillering and filling of earheads as indicated by data in Tables XL and XLI.

TABLE XL

Number of earheads of different classes per plot of 2.5 cents of an acre

Number of the block	Class of the earheads	Sulphate of ammonia	Nitrate of soda	Calcium cyanamide	Nicifos	Complete fertiliser	No fertiliser	Mean of each block
1B	Fully filled	2547	2531	1615	1525	2294	2875	2231
	Half filled	671	829	925	1000	342	180	658
	Blank	445	504	733	574	563	343	527
2B	Fully filled	2475	3420	1780	2050	3010	1400	2356
	Half filled	400	300	1715	850	680	1050	833
	Blank	339	385	673	690	523	651	544
3B	Fully filled	2580	2475	2560	3035	2394	2500	2591
	Half filled	300	165	400	433	475	440	369
	Blank	370	420	387	506	641	735	510
4B	Fully filled	2079	2700	2630	2703	2329	2480	2487
	Half filled	650	210	330	171	463	145	328
	Blank	645	525	616	545	950	685	661
5B	Fully filled	3250	2500	2000	2360	2850	2250	2535
	Half filled	315	495	675	170	195	650	417
	Blank	540	680	740	466	466	935	638
6B	Fully filled	1943	2565	2375	2530	2250	2090	2292
	Half filled	695	185	450	225	295	145	333
	Blank	720	485	820	505	465	850	641
7B	Fully filled	2660	2465	3044	2560	3175	2665	2762
	Half filled	190	425	470	390	85	500	343
	Blank	840	555	625	710	780	750	710
8B	Fully filled	2790	1733	2025	2755	2525	2005	2306
	Half filled	220	615	220	375	175	455	343
	Blank	890	1035	545	830	835	800	823
Mean of the 8 blocks	Fully filled	2540	2549	2254	2440	2603	2283	
	Half filled	430	403	648	452	339	446	
	Blank	599	574	642	603	653	719	
Percentage of total number of earheads	Fully filled	71	72	64	70	72	66	
	Half filled	12	12	18	13	10	13	
	Blank	17	16	18	17	18	21	

TABLE XLI

Number of earheads per plant or tillering

Treatment	Block 1B	Block 2B	Block 3B	Block 4B	Block 5B	Block 6B	Block 7B	Block 8B	Mean of 8 blocks
Sulphate of ammonia	1.43	1.53	1.40	1.62	1.76	1.93	1.58	1.84	1.63
Nitrate of soda ..	1.47	1.74	1.31	1.77	1.51	1.59	1.62	1.90	1.61
Calcium cyanamide	1.40	1.75	1.54	1.83	1.62	1.62	2.13	1.46	1.67
Nicifos ..	1.34	1.56	1.62	1.59	1.49	1.66	1.75	1.77	1.60
Complete fertiliser ..	1.39	1.65	1.73	1.76	1.49	1.52	1.94	1.75	1.65
No fertiliser ..	1.52	1.60	1.64	1.68	1.91	1.79	1.89	1.80	1.73
Mean of each block	1.43	1.64	1.54	1.71	1.63	1.69	1.82	1.75	1.65

Larger the number of plants per unit area, the less is the tillering. The different fertilisers that have nearly the same number of plants have shown also equal tillering but have not been able to increase it over what the number of plants would warrant.

Calcium cyanamide has given the least and nitrate of soda and complete fertiliser the largest proportion of fully filled earheads.

One important factor which contributes to the yield of grain is also the weight per earhead. A study of this from observations as recorded in Table XLII reveals :

(1) The weight per earhead is more orless in the inverse proportion to the number of earheads or in other words the number of bearing plants.

(2) The fertilisers have been able to increase the weight per earhead over the one in compensation for the number of earheads per unit area, nitrate of soda being higher than others in this respect.

TABLE XLII

Average weight per fully filled earhead in tolas

Treatment	Block 1B	Block 2B	Block 3B	Block 4B	Block 5B	Block 6B	Block 7B	Block 8B	Mean of 8 blocks
Sulphate of ammonia	0.38	0.41	0.43	0.43	0.29	0.64	0.53	0.47	0.45
Nitrate of soda ..	0.42	0.35	0.42	0.43	0.46	0.45	0.56	0.68	0.47
Calcium cyanamide	0.43	0.40	0.42	0.43	0.42	0.46	0.47	0.49	0.44
Nicifos ..	0.50	0.41	0.35	0.35	0.39	0.51	0.47	0.47	0.43
Complete fertiliser ..	0.47	0.35	0.54	0.41	0.34	0.50	0.45	0.48	0.44
No fertiliser ..	0.31	0.39	0.33	0.27	0.29	0.45	0.35	0.41	0.35
Mean of each block	0.42	0.35	0.42	0.39	0.37	0.50	0.47	0.50	0.43

V. 1933-34

The work of this year was an exact repetition of that of the previous year.

Position and Description of the Land Selected

The experiment was conducted on plots 1A to 8A. These are the same plots on which this experiment was conducted in the year 1931-32. The previous history of these plots upto the year 1930-31 is given under the year 1931-32 (vide page 1) and after the *bajri* crop of the year 1931-32 of the present experiment was harvested, all these plots had Spanish peanut groundnut crop in the monsoon and gram in the winter season of 1932-33. Both of them were grown as rain-fed crops and were not manured. The groundnut crop yielded 965 pounds pods and the gram crop yielded 270 pounds grain per acre. Fig. 6 shows contours of levels as well as depths of soil upto murum layer and Tables XLIII and XLIV give further description of soil in other respects.

In Table XLIII are recorded moisture contents of soil in plot No. 5A.

Table XLIII

Percentages of moisture contents of soil on oven dry basis

Date			At 0″ to 6″ depth	At 6″ to 12″ depth	At 12″ to 18″ depth
19th July	1933	..	34.70	32.80	24.66
2nd August	1933	..	47.15	47.70	47.60
16th August	1933	..	36.99	36.95	36.57
2nd September	1933	..	31.71	30.82	29.17
16th September	1933	..	34.48	32.48	29.66
30th September	1933	..	31.40	30.82	26.20
14th October	1933	..	29.27	29.68	25.49
28th October	1933	..	28.44	28.64	25.07

Quantity of Fertilisers

Quantities of fertilisers were such as to supply 20 pounds of nitrogen in addition to 1¼ cart loads of farmyard manure per acre.

Arrangement of Plots and Number of Replications

The actual situation of different treatments in each of the eight replications provided is shown in Fig. 9.

Bajri—1933-34

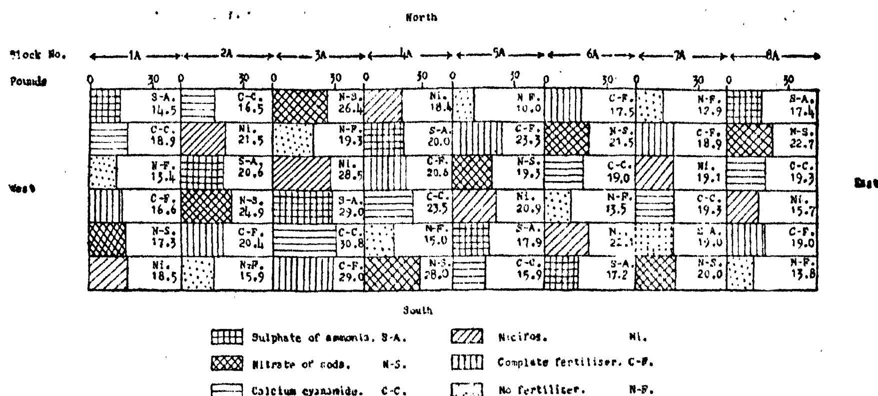


Fig. 9.—Situation of different treatments and yield per plot in pounds.

Cultural Details and Progress of the Crop

The preparatory tillage consisted of ploughing in November 1932 along with the sowing of the previous crop of gram to a depth of about seven inches by a turn-wrest plough followed by discing in the last week of May and blade harrowing in the third week of June and the first week of July. Farmyard manure was applied on 25th May 1933 and well mixed by a disc harrow. Sowing was done on 19th July 1933 with a country drill with a seed-rate of 8½ pounds per acre. The seed-rate was purposely kept so high to compensate with as low as 66 per cent germination obtained in the trial pot. The variety used was Economic Botanist's strain No. 54. The germination had rather thickly come up on account of the high initial seed-rate and therefore the crop was thinned after the germination was completed. Fertilisers were applied as a top-dressing on 12th August by broadcasting between the crop lines and mixed thoroughly with the soil by a pair of entire bladed Deccan hoes. Flowering commenced from 2nd September. About 40 per cent of the earheads were either rendered entirely blank or were only partially filled with grains on account of heavy rains in the first and third weeks of September which was the time of pollination. The effect of fertilisers on the standing crop began to be distinctly noticed from 26th August, *i.e.*, two weeks after their application. The crop on the whole passed a healthy life in all other respects and was harvested on 27th to 31st October 1933.

Results

The details of the yield are set out in Fig. 9 and in Tables XLIV and XLV.

TABLE XLIV

Yield of bajri grains in pounds per plot of 2.5 cents of an acre

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 5A	Block 6A	Block 7A	Block 8A	Mean of the eight blocks	Percentage increase over the check
Sulphate of ammonia ..	14.500	20.625	29.000	20.000	17.875	17.188	19.000	17.438	19.453	37
Nitrate of soda ..	17.250	24.875	26.375	28.000	19.250	21.500	20.000	22.688	22.492	58
Calcium cyanamide ..	18.875	16.500	30.750	23.500	15.875	19.000	19.250	19.250	20.375	43
Nicifos ..	18.500	21.500	28.500	18.375	20.875	22.063	19.063	15.688	20.571	45
Complete fertiliser ..	16.625	20.375	29.000	20.625	23.250	17.500	18.875	19.000	20.656	45
No fertiliser ..	13.375	15.875	19.250	15.000	10.000	13.500	12.875	13.813	14.211	..
Mean of the block ..	16.521	19.958	27.146	20.917	17.854	18.459	18.177	17.980	19.626	..

TABLE XLV

The yield of dry straw in pounds per plot of 2.5 cents of an acre

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 5A	Block 6A	Block 7A	Block 8A	Mean of the eight Blocks	Percentage increase over the check
Sulphate of ammonia ..	25	32	49	32	34	36	38	37	35.4	41
Nitrate of soda ..	33	41	46	46	46	41	45	50	43.5	74
Calcium cyanamide ..	28	31	48	40	33	34	39	40	36.6	46
Nicifos ..	23	34	45	32	39	37	38	33	35.1	40
Complete fertiliser ..	29	34	47	39	37	35	40	38	37.4	49
No fertiliser ..	21	23	27	26	23	26	28	27	25.1	..
Mean of the block	26.5	32.5	43.7	35.8	35.3	35.5	38.0	37.5	35.5	..

Every fertiliser is significantly better than the no fertiliser check, both in respect of grain and straw. In regard to the comparison among fertilisers themselves, nitrate of soda has yielded significantly better than sulphate of ammonia in respect of grain and every other fertiliser in respect of straw.

The percentage increases in straw are generally larger than those of grain with the exception of nicifos. The increases in straw have generally the same order of merit as grain with the exception of nicifos.

The ratio of the yield of straw to the yield of grain was worked out from the data recorded in Tables XLIV and XLV and is presented in Table XLVI.

TABLE XLVI

Ratio of the yield of straw to the yield of grain

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 5A	Block 6A	Block 7A	Block 8A	Mean of 8 blocks
Sulphate of ammonia	1.72	1.55	1.68	1.60	1.90	2.09	2.00	2.12	1.82
Nitrate of soda ..	1.91	1.64	1.74	1.64	2.38	1.90	2.25	2.20	1.95
Calcium cyanamide	1.48	1.88	1.56	1.70	2.07	1.78	2.02	2.07	1.81
Nicifos ..	1.24	1.58	1.57	1.74	1.86	1.67	1.99	2.10	1.71
Complete fertiliser	1.74	1.66	1.62	1.89	1.59	2.00	2.11	2.00	1.82
No fertiliser	1.57	1.44	1.40	1.73	2.30	1.92	2.17	1.95	1.81
Mean of each block	1.61	1.63	1.56	1.72	2.01	1.89	2.09	2.07	1.82

From the above data it is seen that the capacity of vegetative parts to produce grain is the least with nitrate of soda, most with nicifos and intermediate with the rest.

Judging from periodical observations on the standing crop, the treatments showed distinct superiority over check in the number of replications stated against each on dates specified below :—

Treatment	Cases of superiority over check out of eight on dates			
	26-8-33	8-9-33	22-9-33	6-10-33
Sulphte of ammonia ..	6	8	8	8
Nitrate of soda ..	8	8	8	8
Calcium cyanamide ..	6	8	8	8
Nicifos ..	7	8	8	8
Complete fertiliser ..	7	8	8	8

Most of the plots which appeared superior to check during the growing period have also given superior final yields.

INFLUENCE OF FERTILISERS ON THE QUALITY OF BAJRI GRAINS

The differences in quality were very slight and not enough to affect the market value. The different treatments stood in the order of (1) nicifos, calcium cyanamide and nitrate of soda, (2) complete fertiliser and sulphate of ammonia and (3) no fertiliser.

The food-value analyses of the representative samples of *bajri* grains are given below :—

Food constituents in percentage	Sulphate of ammonia	Nitrate of soda	Calcium cyana-mide	Nicifos	Complete fertiliser	No fertiliser
Moisture ..	9.35	9.55	9.30	9.25	9.65	9.80
Ether extract ..	5.59	5.50	5.45	5.55	5.65	5.65
Albuminoids* ..	8.13	8.31	7.56	7.56	8.06	7.50
Digestible carbohydrates ..	74.37	74.14	75.14	74.94	74.24	74.10
Woody fibre ..	0.65	0.80	0.70	0.70	0.80	0.75
Ash** ..	1.95	1.70	1.75	2.00	1.60	2.20
Containing—						
*Nitrogen ..	1.30	1.33	1.21	1.21	1.29	1.20
**Sand ..	0.27	0.07	0.11	0.22	0.17	0.37

The albuminoids are the highest with nitrate of soda even with the highest yield of grain. The woody fibre is the highest with nitrate of soda and complete fertiliser and the lowest with sulphate of ammonia. Ash content with sulphate of ammonia and nicifos is higher than other fertilisers but less than no fertiliser.

With a view to study as to how the different fertilisers act and the reasons of difference in their behaviour, data were collected in regard to the soil and the various phases of plant growth.

The means of different block yields of grain afford a good comparison of the effect of soil. These vary from 16.521 to 27.146 (Table XLVII) giving thereby a range of variation of—16 to +36 per cent from the general mean. The soil of block 3A which has given the highest yield does not show any marked superiority in respect of colour, texture and levels which appear to be nearly the same in all the blocks.

A study of the number of plants per plot as recorded in Table XLVII shows:

(1) Other conditions remaining the same, the variations in the number of plants have not caused any consistent difference in the yield per unit area.

(2) The stand of the crop in the case of sulphate of ammonia, nitrate of soda and nicifos is about seven per cent better than the rest.

TABLE XLVII

Number of plants per plot of 2.5 cents of an acre

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 5A	Block 6A	Block 7A	Block 8A	Mean of 8 blocks
Sulphate of ammonia	1122	1569	1838	1653	1623	1467	1743	2141	1645
Nitrate of soda ..	1411	1614	1483	1781	1675	1420	1738	1979	1638
Calcium cyanamide..	1079	1306	1709	1575	1353	1720	1742	1966	1556
Nicifos ..	1385	1486	1723	1457	1720	1766	1723	1804	1633
Complete fertiliser ..	1434	1546	1672	1639	1326	1352	1338	1745	1507
No fertiliser ..	1187	1363	1623	1566	1329	1713	1367	1968	1515
Mean of each block..	1270	1481	1675	1612	1504	1573	1609	1934	1582

Other phases studied are tillering and filling of earheads as indicated by data in Tables XLVIII and IL

TABLE XLVIII

Number of earheads of different classes per plot of 2.5 cents of an acre

Number of the block	Class of the earheads	Sulphate of ammonia	Nitrate of Soda	Calcium cyanamide	Nicifos	Complete fertiliser	No fertiliser	Mean of each block
1A	Fully filled	1565	1588	1640	1434	1840	1212	1546
	Half filled	645	747	548	1045	864	1013	477
	Blank	377	236	625	525	432	618	469
2A	Fully filled	1722	1897	1485	1918	1845	1683	1758
	Half filled	605	645	982	613	400	727	662
	Blank	253	274	239	257	365	602	332
3A	Fully filled	1965	1655	2257	1827	1645	1841	1865
	Half filled	754	768	442	689	734	508	649
	Blank	549	315	587	553	552	387	491
4A	Fully filled	1544	1628	1902	1673	1694	1661	1594
	Half filled	1009	809	774	1105	744	554	833
	Blank	285	255	507	439	413	770	445
5A	Fully filled	1552	1711	1309	1346	1592	1278	1465
	Half filled	511	715	713	921	843	418	687
	Blank	423	297	382	525	310	509	408
6A	Fully filled	1193	1426	1266	1764	1535	1217	1400
	Half filled	577	737	870	358	455	1015	668
	Blank	505	248	420	535	523	568	467
7A	Fully filled	1645	1083	1256	1467	1174	1164	1298
	Half filled	522	608	536	580	738	884	645
	Blank	253	523	405	498	358	490	421
8A	Fully filled	2055	1721	1882	1399	1763	1483	1709
	Half filled	394	460	485	857	596	803	584
	Blank	343	382	500	482	472	651	472
Mean of 8 blocks	Fully filled	1655	1589	1625	1604	1636	1442	..
	Half filled	627	686	669	771	672	740	..
	Blank	374	316	458	477	428	574	..
Percentage of total number of earheads	Fully filled	62	61	59	56	60	52	..
	Half filled	24	27	24	27	24	27	..
	Blank	14	12	17	17	16	21	.

TABLE IL

Number of earheads per plant or tillering

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 5A	Block 6A	Block 7A	Block 8A	Mean of 8 blocks
Sulphate of ammonia	2.31	1.64	1.78	1.72	1.53	1.55	1.39	1.30	1.65
Nitrate of soda ..	1.82	1.74	1.84	1.51	1.63	1.70	1.27	1.30	1.60
Calcium cyanamide	2.61	2.07	1.92	2.02	1.78	1.49	1.26	1.45	1.82
Nicifos ..	2.17	1.88	1.78	2.21	1.62	1.50	1.47	1.52	1.77
Complete fertiliser ..	2.18	1.68	1.75	1.74	2.07	1.56	1.70	1.62	1.83
No fertiliser ..	2.39	2.21	1.69	1.91	1.66	1.63	1.86	1.49	1.86
Mean of each block	2.25	1.87	1.79	1.85	1.72	1.57	1.49	1.45	1.76

Larger the number of plants per unit area the less has been the tillering. The different fertilisers that have nearly the same number of plants have also shown fairly equal tillering but have not been able to increase it over what the number of plants would warrant.

No fertiliser has given the least and sulphate of ammonia the largest proportion of fully filled earheads.

One important factor which contributes to the yield of grain is also the weight per earhead. A study of this from observations as recorded in Table L reveals :

(1) The weight per earhead has not got any consistent relation with the number of earheads or in other words with the number of bearing plants.

(2) The fertilisers have been able to increase the weight per earhead over the one in compensation for the number of earheads per unit area, nicifos being higher than others in this respect.

TABLE L

Average weight per fully filled earhead in tolas

Treatment	Block 1A	Block 2A	Block 3A	Block 4A	Block 5A	Block 6A	Block 7A	Block 8A	Mean of 8 blocks
Sulphate of ammonia	0.46	0.56	0.78	0.57	0.56	0.61	0.52	0.40	0.56
Nitrate of soda ..	0.60	0.69	0.76	0.74	0.66	0.68	0.69	0.60	0.55
Calcium cyanamide	0.52	0.53	0.79	0.58	0.28	0.59	0.59	0.45	0.54
Nicifos ..	0.52	0.56	0.86	0.51	0.58	0.57	0.58	0.44	0.58
Complete fertiliser ..	0.48	0.64	0.79	0.54	0.54	0.24	0.70	0.49	0.55
No fertiliser ..	0.31	0.45	0.52	0.41	0.34	0.40	0.46	0.35	0.41
Mean of each block	0.48	0.57	0.76	0.56	0.49	0.52	0.59	0.46	0.53

VI. Review of Results of All Years Taken Together

(1) The percentage increases in the yield of *bajri* grains and straw contributed by the different fertilisers over the no fertiliser check, the average yield of no fertiliser check plots and the average yield per acre on the whole during the course of five years are recorded in Tables LI and LII. The italic figures in these tables denote that they are statistically significant over the no fertiliser check.

Table LI

Comparative study of the five years' results obtained in the case of bajri grain

Percentage increase over the check

Treatment	1929-30	1930-31	1931-32		1932-33	1933-34
	10 pounds nitrogen	10 pounds nitrogen	10 pounds nitrogen	20 pounds nitrogen	20 pounds nitrogen	20 pounds nitrogen
Sulphate of ammonia	16.9	4.94	9.30	23.12	*39.3*	*37*
Nitrate of soda ..	9.7	*11.91*	10.71	*46.25*	*43.4*	*58*
Calcium cyanamide ..	25.7	3.73	*17.39*	*36.56*	*28.4*	*43*
*Nicifos ..	22.1	2.44	14.41	*46.41*	*32.6*	*45*
**Complete fertiliser	17.1	3.94	11.06	21.88	*40.0*	*45*
Average yield of grain of check plots per acre in pounds	1031	923	569	640	668	568
Average yield of grain on the whole per acre in pounds	1188	965	629	826	873	785

* In the year 1929-30 Leunaphos occupied the place of nicifos.

** In the year 1929-30 Nitrophoska occupied the place of complete fertiliser.

Table LII

Comparative study of the five years' results obtained in the case of bajri straw

Percentage increase over the check

Treatment	1929-30	1930-31	1931-32		1932-33	1933-34
	10 pounds nitrogen	10 pounds nitrogen	10 pounds nitrogen	20 pounds nitrogen	20 pounds nitrogen	20 pounds nitrogen
Sulphate of ammonia	13.9	14.26	*23.5*	*35.3*	*37.5*	*41*
Nitrate of soda ..	14.4	*19.74*	*45.7*	*81.2*	*54.2*	*74*
Calcium cyanamide ..	12.6	11.50	*30.9*	*62.4*	*25.0*	*46*
*Nicifos ..	8.9	8.74	16.0	*56.5*	*25.0*	*40*
**Complete fertiliser ..	13.7	15.00	*27.4*	*38.8*	*25.0*	*49*
Average yield of straw of check plots per acre in pounds	3135	2000	1296	1360	960	1004
Average yield of straw on the whole per acre in pounds	3467	2230	1608	1984	1240	1420

* In the year 1929-30 Leunaphos occupied the place of nicifos.

** In the year 1929-30 Nitrophoska occupied the place of complete fertiliser.

All the forms of nitrogen when applied at the rate of 10 pounds per acre during the first three years have not brought about substantial increases in the yield of grain and straw and most of the increases are not statistically significant. When the rate of application of nitrogen was however raised to 20 pounds per acre in the last three years, all the forms of fertilisers have yielded fairly large increases of grain and straw and almost all of them are statistically significant. This indicates that 10 pounds nitrogen was not sufficient to markedly influence the plant growth.

The proportion of grain to straw has varied directly with the quantity of nitrogen dose and inversely with the yield of straw.

With all the fertilisers and particularly nitrate of soda, the yield of straw is more than commensurately increased as compared to grain. This agrees with the finding of Russell (1932) that the increased yield of straw contributed by nitrogenous fertiliser is mainly the result of an increased length and thickness of the ear-bearing stems.

As regards the different forms of nitrogen, it is only the 20 pounds dose that affords a comparison. Nitrate of soda has been found to be the best of all. This outstanding effect of nitrate of soda observed in the present experiment is in close agreement with the five years' results of Richardson and Gurney (1933) in Australia on cereal crops of wheat and barley. Nicifos stands second in the order of merit. All other forms with slightly fluctuating ranks from year to year stand next. Recently sulphate of ammonia at the rate of 60 pounds (=about 12 pounds nitrogen) per acre was tried with this crop at Prantij (Gujarat) and has yielded 5 to 29 per cent increase which fairly agrees with the results of this fertiliser in the present experiment.

When phosphoric acid is added to nitrogen as in the form of nicifos or complete fertiliser, extra benefit is not consistently obtained over the one yielded by nitrogen alone in the form of nitrate of soda or sulphate of ammonia.

The addition of potash by way of complete fertiliser does not appear to alter the position obtained by the combination of nitrogen and phosphoric acid.

No previous work on the effect of phosphoric and potassic fertilisers on this crop is available for comparison.

(2) As regards the **quality of produce,** the five years' results taken together indicate that the fertilisers applied either at the rate of 10 or 20 pounds nitrogen per acre have little effect on colour, size, hardness and uniformity of grain and in any case are not sufficient to affect the market value of the grains. The slight differences that are noticeable are in the fairly consistent order of nicifos, nitrate of soda, sulphate of ammonia and complete fertiliser with the 10 pounds and of calcium cyanamide and nicifos or sulphate of ammonia with the 20 pounds dose; the position of other fertilisers is fluctuating in different years.

Judging the quality from the food-values, the several years' results examined side by side indicate that the albuminoid content in grain is generally higher with the addition of nitrogenous fertilisers excepting the case of one out of four years and when the general yields from year

to year are higher. No consistency is noticed in regard to the specific effects of the different forms of nitrogen on the albuminoid content. No such relation can be established with regard to the other food constituents. Russell (1931) considers that by the application of the relatively smaller amount of nitrogen (*e.g.*, one cwt. of sulphate of ammonia or nitrate of soda per acre), the net result is a larger plant not much different in composition from the original. According to McCarrison (1924—1926) the food grains from plots treated with natural manures are superior in nutritive and vitamin value than those from plots manured with artificials.

(3) The data collected for examining the **economic side** of the results are recorded below :—

Name of the fertiliser	Quantity of fertiliser applied per acre in pounds	Actual quantities of increase in the yield of bajri grain and straw in pounds per acre contributed by different fertiliser treatments in the years					
		1931-32		1932-33		1933-34	
		Grain	Straw	Grain	Straw	Grain	Straw
Sulphate of ammonia	96	..	..	262.5	360	210	412
Nitrate of soda ..	133	296	1104	290	520	331	736
Calcium cyanamide..	112	234	848	190	240	247	460
Nicifos ..	111	297	768	217.5	240	254	400
Complete fertiliser ..	252	..	..	267	240	258	492

With these increases it will be seen that the use of each of the fertilisers at 20 pounds nitrogen per acre can only be profitable provided—

(i) the bajri grains and straw could be sold respectively at 22 pounds and 333 pounds or less per rupee ;

and

(ii) the fertilisers can be purchased at or cheaper than the prices mentioned below against each in pounds per rupee.

Sulphate of ammonia	16
Nitrate of soda	17
Calcium cyanamide	20
Nicifos	17
Complete fertiliser	37

The range of actual prices of sale of bajri products and purchase of fertilisers prevailing in these years is stated below :—

Bajri grains	28 to 35
Bajri straw	333
Sulphate of ammonia	16 to 19
Nitrate of soda	11 to 13
Calcium cyanamide	11.5 to 13
Nicifos	10 to 12.5
Complete fertiliser	17.5 to 18.5

It will thus be seen that during the period of experiment the use of sulphate of ammonia has alone been slightly profitable.

4. The yields obtained and data collected on the **factors of climate and soil** were examined with a view to see how far and in which manner differences in them can account for the differences in the behaviour of fertilisers noticed in the various results.

On a reference to Tables LI and LII, it is observed that the yields of grain show no consistent relation with percentage increases but the straw yields indicate a tendency of an inverse relation with 10 pounds and a direct relation with 20 pounds nitrogen doses.

In the following statement the facts bearing on the influence of rainfall, the most important factor of climate, are brought together.

Year	Date of sowing	Date of harvesting	Rain upto sowing in inches	Rain upto harvesting in inches	Remarks about distribution of rain	Yield of grain in lbs. per acre	Yield of straw in lbs. per acre
1929-30 ..	10-7-29	30-9-29	7.80	17.88	Good distribution, heavy rains in the third week of Sept., no record of blank or partially filled earheads taken	1188	3467
1930-31 ..	9-7-30	11-10-30	9.52	24.00	Drought in August, heavy rains in the first week of Sept., 35 per cent of eareads blank or partially filled	965	2230
1931-32 ..	21-7-31	18-10-31	5.90	21.66	Drought from middle of Aug. to middle of Sept., heavy rains in the third week of Sept., 38 per cent of earheads blank	10N—629 20N—826	1608 1984
1932-33 ..	12-7-32	14-10-32	8.00	23.05	Continuous rains during the first four weeks from sowing, heavy rains in first week of Sept., 30 per cent of earheads blank or partially filled	873	1240
1933-34 ..	19-7-33	31-10-33	12.00	34.34	Good distribution, heavy rains in the third week of Sept., 40 per cent of earheads blank or partially filled	785	1420

The amounts of rain during the growing period which are also reflected in the fortnightly moisture contents of soil appear to have an inverse relation with yields in general. The cause of the lowest yield with 10 lbs nitrogen in 1931-32 appears however to be insufficient rain made up of light showers which left the seed-bed comparatively loose and dry, giving a very poor germination and stand of the crop.

Higher temperatures (Fig. 2) appear to be associated with higher yields in general.

Finer texture and darker colour of the soils used in 1929-30 appear to be associated with higher yields than coarser texture and lighter colour in the remaining years. The average depths of soils which have varied between 13 to 17 inches, do not appear to have any relation with yields. It is not possible to interpret the influence of differences in slopes, as they are mixed with those of many other factors. The total nitrogen content of the soils used do not appear to have a relation with the yields, nor have nitrogenous fertilisers containing also phosphoric acid and potash shown better effect on soils comparatively deficient in these plant foods. Variation in the lime content of the soil does not appear to have caused the differences in the behaviour of fertilisers.

5. A review of the observations noted from year to year in regard to the various plant phases such as the **number of plants, tillering and weight per earhead,** as bringing about variations in the effects of fertilisers reveals that :

(1) The average number of plants per plot of 2.5 cents of an acre has varied from 1142 to 2151. The smaller numbers (1931-32) are found to be the consequence of a dry and loose seed-bed having given poor germination while the larger number (1932-33) appears to be associated with adequate moisture conditions immediately after sowing. The yield of grain seems to depend in only a small direct proportion, on the number of plants.

(2) Generally, larger the number of plants, the less has been the tillering, other conditions being equal. Fertilisers do not on the whole seem to have caused any difference in tillering, over and above that caused by the number of plants.

(3) The weight per earhead has some inverse relation with the number of earheads per unit area. With the application of fertilisers, the increment is more than the quantity in compensation for the number of earheads per unit area. When fertility of the soil is inherently more, similar result is observable.

(4) The conclusion of all this is that the higher yields whenever obtained are brought about only by an increase in the weight per earhead either as a result of natural or added fertility.

6. The **residual effect** of different fertilisers as judged from eye observations of standing crop, could not be noticed to any marked extent on the subsequent crops of groundnut in plots 1B to 8B in the year 1931-32 and Nilwa jowar in plots 1A to 8A in the year 1932-33, in plots 1B to 8B in the year 1933-34 and in plots 1A to 8A in the year 1934-35. In this connection Shutt and Wright (1931) observed that the readily available nitrogenous fertilisers are for practical purposes to be considered as effective only in the year of their application. Harrison's (19 3) experiments at Welshpool indicate that the residual effect of the phosphatic fertilisers is not felt on the next crop. The experiments recently conducted by the Imperial Chemical Industries Ltd., at Shanghai, China (1933) have established that the phosphatic and potassic fertilisers do not leave residual effects. Coleman (1917) is of opinion that the mineral manures as a class have very little residue and their action seems to be spent up during the season in which they are applied. Viswa Nath (19 2) also did not find residual effect of mineral fertilisers. Our observations regarding the residual effect of these fertilisers do not thus materially differ from the above findings of other investigators.

EFFECT OF X-RAYS ON THE RATE OF EGG LAYING IN DROSOPHILA MELANOGASTER RACE KALYAN

By

S. S. PRABHU

Wadia College, Poona

AND

M. S. DALAL,

Elphinstone College, Bombay

INTRODUCTION

WHILE 100 to 200 papers are being published annually on mutation and allied subjects in Drosophila, those on the egg production in these flies amount to a handful. Shapiro (1928) worked out the rate of oviposition in Drosophila melanogaster and two races of Drosophila obscura ; Guyenot (1912), Adolf (1920), Hansen and Ferris (1929) and Alpatov (1932) studied the effects of certain factors on egg laying in Drosophila melanogaster ; Pearl (1928) worked out the effect of density of population on egg production in the same fly ; Donald and Lamy (1936) investigated the "ovarian rhythm" discovered by Shapiro (1932) in Drosophila pseudo-obscura ; Dobzhansky (1935) observed the fecundity in the same fly at different temperatures ; and Auerbach (1937) in Drosophila funebris (egg mutant "Spheroidal") and Prabhu (1939) in Drosophila pseudo-obscura (egg mutant "Filament") noted the extraordinary disturbances in the shape, size, fecundity, and fertility of their eggs. The papers enumerated above have but lightly touched on the numerous problems dealing with egg production, so that the field is still open for further investigations. The rate of egg production in relation to external and internal factors is one that will come to the fore in the near future for, is it not in the egg's reaction to the changes within its chromosomes or cytoplasmic material that the key to the problem of mutations lies ? The importance of this aspect of the problem in egg production becomes all the more paramount, when we consider how a clearer insight into the various factors conditioning egg formation in this fly, will enable us to take on with confidence similar problems elsewhere, especially in Locusts, where the problem has assumed such gigantic proportion that it costs the Indian tax-payer alone several lakhs of rupees annually.

Egg production studies offer many practical difficulties. This in main is due to the fact that egg production is conditioned by innumerable factors of which the genetic constitution, feeding (both larva and adult),

light, temperature and humidity are more important. Effects produced by these factors however are known and can be controlled ; but no information is available regarding the actual conditions necessary inside the ovarian tubules for the formation of eggs. Hence it is not possible to control the latter, at least directly. An indirect method however is possible and that is through the standardisation of the genetic constitution of the experimental flies by a process of close inbreeding extending over numerous generations. Flies thus obtained will have a greater degree of similarity with each other than flies taken from a random breeding population and therefore are expected to behave in a like manner. If now these flies are subjected to a given experimental condition, while keeping all other conditions constant, a fair idea of the effect of that condition on egg production will be obtained. This is the method employed by us in the following study where the effect of X-rays was tried on the rate of egg laying in Drosophila melanogaster, Race Kalyan. A complete description of this local variety of Drosophila melanogaster together with other new species and varieties of Drosophila indigenous to India will form the subject matter of another paper.

MATERIAL AND METHOD

The females used in this experiment were the descendants of wild female individuals of Drosophila melanogaster trapped at Kalyan. They were raised in the laboratory on synthetic food described by Bridges (1937), in half-pint milk bottles closed with cotton plugs. The cultures from generation to generation were maintained by brother-sister matings. Only those cultures that showed a high degree of fertility were utilised in making succeeding cultures. In this manner at least 15 generations must have elapsed before the present experiment was undertaken. Thus a high degree of homozygosity was ensured in the females actually used in the experiment. The following precautions were also taken as Drosophila females are highly susceptible to changes in environment. They are :

(1). Non-crowding of larvæ in culture bottles. Females of the same age were selected and the eggs laid by them in a certain period collected and distributed in vials containing equal quantities of Bridges' food. 500 eggs only were added to bottles containing 1" of standing fly food. This ensured the growing larvæ a liberal supply of food.

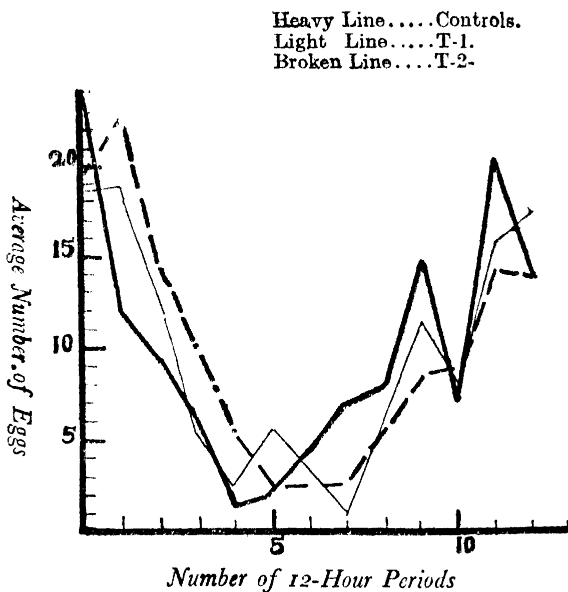
(2). Proper feeding of adults. Adults live on yeast. If the food in which the fly is made to lay eggs is not yeasted, an immediate drop in the egg output results. This is clearly brought out in graph No. 1.

(3). Optimum temperature, humidity and light. Each one of these factors affects egg laying. For instance, fewer eggs are laid in day than at night, as also at lower temperatures than at higher ones. The number of eggs laid however does not increase in the same proportion as the temperature increases. Hence the experimental flies have to be kept at the same temperature, either in total darkness or total light and under similar conditions of humidity.

GRAPH No. 1.

EFFECT OF YEASTING ON THE RATE OF EGG PRODUCTION

Heavy Line.....Controls.
Light Line.....T-1.
Broken Line....T-2.



THE X-RAYING

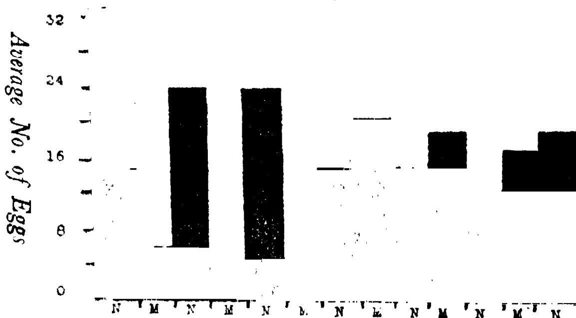
Adult females that emerged within a given interval (6 hrs.) were selected and put in vials containing ripe bananas for 36 hours, after which they were transferred to small celluloid ampules and subjected to X-ray treatment using 12 cms target distance, 90 K.V. peak, 5 m. amp. current and a low filter. The flies were divided into two sets. The first set called T-1 was exposed for 5 mins. *i.e.*, the flies in this set received about 800 r units of X-ray. The second set received a larger exposure, being kept for 15 mins. and thus received three times 800 or 2400 r units.

DISTRIBUTION OF THE TREATED FEMALES

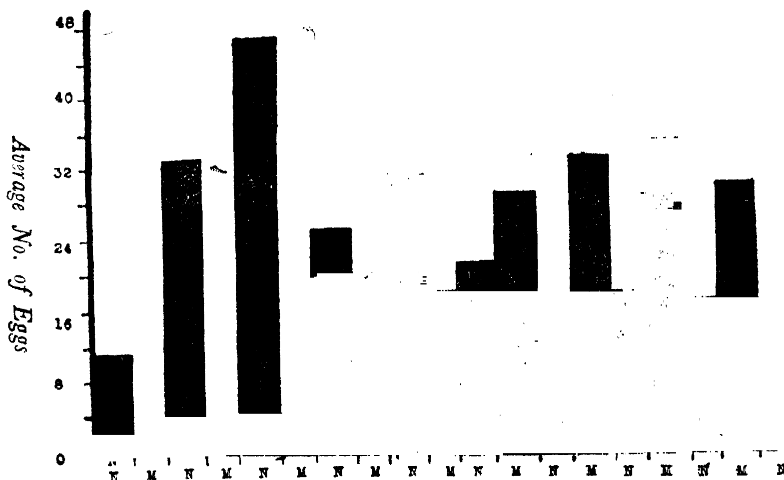
The treated females were then divided into two lots. One lot was kept entirely in the dark, whereas the other was just left outside in the laboratory. The former contained in all 26 females (10 in T-1 and 16 in T-2) and the latter 25 (10 in T-1 and 15 in T-2). In addition, controls containing 6 females each were maintained in each lot. Flies kept in dark are referred to as dark series or simply by the capital letter D. Thus DT-2 means a fly of the dark series which has received a high dose of X-rays, while T-2 simply means a non-dark series fly which also has received a high dose of X-rays.

In the collection of the eggs, the spoon technique described by Crew (D. I. S. No. 5) with a slight modification was used. Instead of paper spoons, aluminium spoons were used and instead of flatting chunks of semi-solid fly food on the spoons, the freshly prepared food was run straight into the spoons and allowed to cool there. When the food in the spoons was thoroughly cooled, its surface was brushed with a fine live-yeast suspension. In order to give sufficient time for the yeast cells

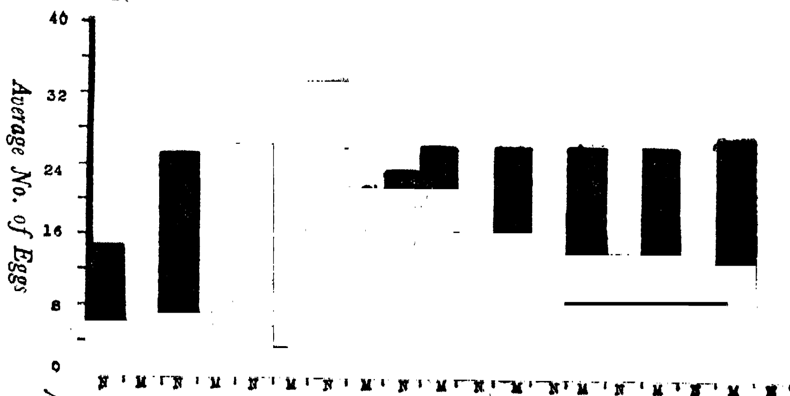
GRAPH NO. 2.
AVERAGE EGG RECORD OF C FEMALES



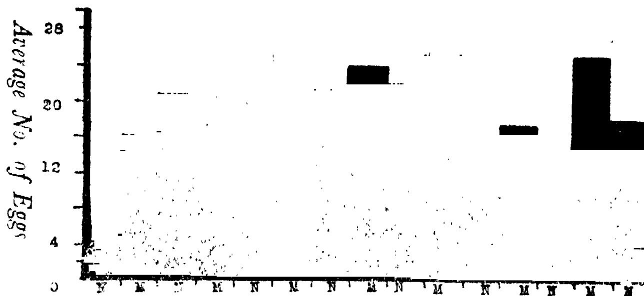
GRAPH NO. 3.
AVERAGE EGG RECORD OF T-1 FEMALES



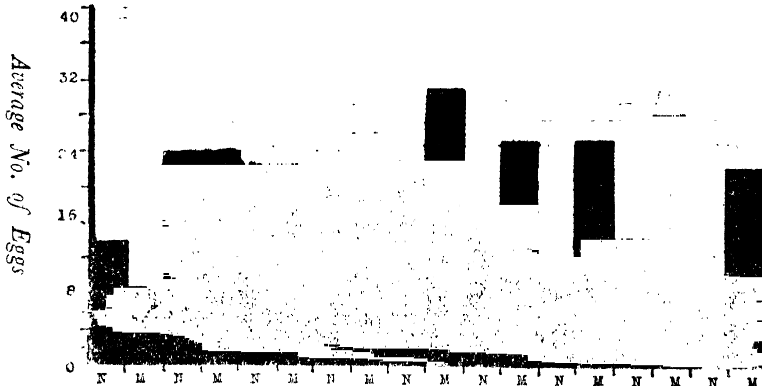
GRAPH NO. 4.
AVERAGE EGG RECORD OF T-2 FEMALES



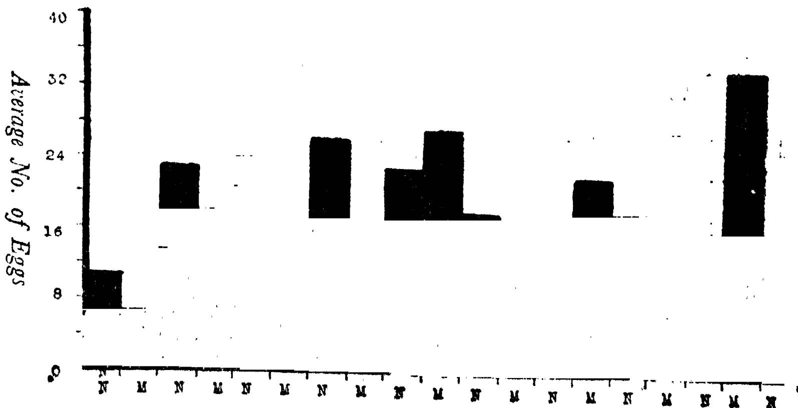
GRAPH No. 5.
AVERAGE EGG RECORD OF DC FEMALES



GRAPH No. 6.
AVERAGE EGG RECORD OF DT-1 FEMALES



GRAPH No. 7.
AVERAGE EGG RECORD OF DT-2 FEMALES



to grow and multiply, at least 6 to 8 hours were allowed before the spoons were used in the experiment. Night spoons were prepared in the morning and the morning ones at night. In changing of the spoons too, great care was taken to see that the females were not disturbed. This was done by taking advantage of the light reactions of the fly itself. When the vial containing the flies is held with its open end away from the light, they will fly towards the light, *i.e.*, away from the open end, and the exchange of spoons can be effected with the least disturbance to them. Violent and rough handling of the vials containing the females also effects the egg output.

In each vial one female and two males were kept. If any of the males died by chance, they were immediately replaced. Egg counts were made twice a day; one at 9 a.m. and the other at 9 p.m. As the effect of X-rays wears off after 5 to 6 days, the egg records were kept only for about 10 days. Following are the egg records so obtained. They are brought out graphically in Graph Nos. 2—7.

TABLE I

EGG LAYING RECORDS OF NON-DARK SERIES FLIES

(*i*) *Control*

Fly No.	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	Total
1	..	...	27	..	7	...	..	1	..	39	3	34	..	8	11	13	12	29	...	184
2	..	..	51	..	14	..	25	1	38	9	..	2	14	10	9	2	..	29	4	208
3	...	..	38	..	38	..	..	4	49	13	6	31	1	21	28	23	15	18	10	295
4	...	...	6	..	43	..	42	17	25	20	29	21	22	22	25	37	25	9	12	355
5	..	...	32	18	19	16	28	1	44	20	19	14	11	13	20	8	1	11	1	276
6	..	..	42	20	24	..	48	4	39	20	29	14	24	30	21	28	21	26	13	403

(*ii*) *T—1*

Fly No.	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	Total
1	8	6	25	20	25	17	29	20	20	18	25	28	3	36	26	36	10	36	2	390
2	..	...	10	..	70	..	15	5	52	28	24	36	10	34	29	38	26	37	19	433
3	..	...	70	..	51	..	49	25	42	15	48	32	14	51	19	52	29	28	22	547
4	...	..	45	..	45	..	41	15	27	18	13	41	5	38	14	31	19	10	3	365
5	7	..	52	1	59	..	38	18	46	23	33	29	20	36	30	38	22	41	9	502
6	10	..	41	..	43	..	2	21	26	24	15	23	6	20	9	35	..	26	4	305
7	..	2	21	15	43	..	9	51	12	22	21	30	27	34	6	46	11	26	..	376
8	..	..	24	..	56	..	2	11	41	..	1	20	20	13	..	19	2	19	3	231
9	19	4	28	5	37	24	8	38	22	21	26	19	12	43	29	40	21	42	20	458
10	..	..	7	..	20	1	35	10	4	3	8	33	1	23	15	15	13	34	4	226

(iii) T—2

Fly No.	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	Total
1	..	..	31	2	38	5	35	17	23	26	24	18	19	25	23	19	25	25	21	376
2	19	..	18	9	41	2	30	23	18	34	14	32	7	20	24	36	8	35	3	373
3	..	1	34	4	37	..	45	22	29	20	22	16	19	27	17	25	17	33	5	373
4	..	..	28	1	24	..	23	6	37	8	12	3	3	18	1	14	17	25	4	224
5	..	13	5	5	33	..	46	23	15	30	27	26	9	35	19	40	..	40	25	390
6	..	8	31	6	32	2	41	25	28	31	19	26	7	41	17	32	..	33	10	389
7	10	..	21	1	..	..	..	23	1	34	..	29	..	26	7	35	..	16	..	203
8	33	..	24	1	39	..	50	14	26	26	..	45	..	5	3	12	28	25	..	331
9											Did not lay.			Examined for 9½ days						
10	16	8	27	21	21	14	41	31	19	32	30	36	3	32	11	37	9	28	4	420
11	..	11	23	19	20	14	22	22	22	28	18	17	8	18	18	20	35	22	..	337
12											Did not lay.			Examined for 9½ days						
13	..	..	56	..	..	..	58	5	31	24	..	37	12	28	..	27	..	41	2	321
14	4	14	9	12	27	1	14	26	20	15	9	28	3	17	9	9	1	5	..	223
15	9	..	19	16	27	7	30	33	28	35	28	28	17	41	29	36	25	27	27	462

M=Morning Count.
N=Night Count.

TABLE II

EGG LAYING RECORDS OF DARK SERIES FLIES

(i) D. Control

Fly No.	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	Total
1	..	..	26	14	28	16	11	22	25	17	12	15	6	28	27	29	30	27	21	354
2	..	11	22	24	17	22	..	32	8	29	14	5	15	18	9	24	..	6	5	261
3	6	9	20	27	32	19	33	25	37	27	27	14	26	28	16	29	6	15	1	297
4	..	20	18	26	21	20	24	29	25	25	7	33	16	..	..	..	..	..	..	Died
5	..	25	32	18	30	25	34	23	19	24	22	25	11	24	18	31	23	28	25	437
6 •	1	13	7	20	20	20	21	13	19	28	11	11	16	..	..	..	..	..	..	Died

(ii) *DT—1*

Fly No.	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	Total
1	4	4	22	18	23	22	26	23	29	24	30	21	26	23	29	28	27	24	10	413
2	7	13	5	39	14	26	17	27	10	29	2	6	..	25	18	26	10	26	..	300
3	..	22	28	21	6	33	28	22	29	33	33	28	23	26	35	35	17	22	14	355
4	..	4	5	7	8	5	6	9	4	8	6	6	3	7	8	10	..	..	5	101
5	21	5	28	28	25	28	26	20	36	32	33	22	22	10	..		Died		..	..
6	2	4	34	19	25	16	16	27	26	32	13	23	3	1	Died		..	..	..	..
7	34	22	22	29	34	22	21	42	22	40	6	51	13	39	27	22	7	19	..	472
8	23	7	24	24	34	23	32	30	28	34	24	20	11	20	9	3	..	..	..	..
9	7	7	35	29	39	23	41	30	46	29	33	31	23	41	1	43	3	19		480
10	..	1	40	22	24	27	29	29	3	52	3	43	..	54	..	56	7	45	4	489

(iii) *DT—2*

Fly No.	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	N	M	Total
1	18	9	25	28	34	17	22	35	16	39	22	19	..	32	27	27	25	38	..	433
2	..	1	47	7	27	12	39	9	27	26	18	2	4	21	27	27	..	50	..	344
3	7	1	29	14	26	22	31	27	29	27	33	6	23	25	27	28	20	30	25	430
4	19	10	25	25	32	17	33	13	22	31	22	6	Died							
5	25	4	33	26	36	25	40	27	36	30	28	36	26	33	35	32	29	36	7	544
6	..	6	19	12	24	16	26	13	28	17	25	10	17	25	26	29	29	19	25	366
7	..	12	25	13	27	25	29	23	36	25	30	33	25	22	29	32	37	27	10	460
8	..	29	22	15	18	19	13	22	10	25	14	14	4	18	12	16	8	27	10	296
9	..	21	11	31	20	15	14	21	12	27	4	42	17	28	23	35	..	51		372
10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Did not lay*		
11	9	7	15	11	13	15	18	17	12	15	21	21	..	11	4	2				
12	8	..	34	25	12	30	25	20	5	40	4	10	5	20	..	30	11	37	..	322
13	5	6	17	16	19	18	27	11	31	32	15	2	13	16	13	29	24	32	14	340
14	7	..	36	33	26	21	26	26	28	30	16	19	14	34	8	40	10	30	14	408
15	..	1	24	6	35	7	23	11	25	20	..	6	1	6	..	21	..	30	1	217
16	..	1	6	21	19	19	28	21	24	25	19	15	20	17	22	Died				

M=Morning Count.
N=Night Count.

* Examined for 9½ days.

RESULTS

In all, we have observed the egg production in 101 treated females (50 in a preliminary experiment, results of which are not shown here and 51 in the present experiment, results of which alone appear here) and we find that only 5 out of these did not lay any eggs at all and 3 laid eggs which were abnormal. In the controls there were no abnormal layers, though a single non-layer was met with in a total of 29 females. The eggs of abnormal layers were peculiar, being stunted in growth with deformed filaments and in many cases transparent. They were all, without exception, sterile. Further, these abnormal layers were observed only in the high dosage series.

Day and Night Effect

A clear difference in the day and night counts of eggs was noted in the case of non-dark series flies. They deposited in the first few days more eggs during the night than during the day ; later on, they changed it to more eggs during the day than during the night. In the flies of the dark series, no definite day and night effects were observed in the first few days; but later on, they too showed a preference to laying more eggs during the day than during the night. This would mean that Drosophila normally prefer day to night for laying eggs. The reason why fewer eggs were obtained in the first instance during the day in the non-dark series, and identical number of eggs during the day and night in the dark series, may be sought in the behaviour of these flies to experimental conditions. In the former instance when flies were kept at laboratory conditions, disturbance of any kind was likely to tell on the number of eggs the fly would lay. These disturbances are not wanting in a laboratory during the day time and hence the fewer number of eggs found in the night count. Whereas, the disturbing factors when the flies are kept in the dark, are reduced to a minimum and hence the flies can have more time at their disposal for laying eggs. As this time will not vary with day or night, as conditions are the same both during the day and during the night, the flies will have approximately the same amount of time at their disposal to lay eggs and therefore the number of eggs laid also will be approximately the same. Later on however, they get used to the experimental conditions and also to numerous disturbances which have now become familiar to them and with that will return their normal tendencies. It is to be noted however that day and night affect only the rate at which the eggs are laid and not the rate at which they are produced ; the latter is conditioned by entirely different factors. A look at the total eggs produced in a given time by the dark and non-dark series given below will make this point clear. Irrespective of the fact whether they were coming from dark or non-dark series, flies from both the series laid on an average, the same number of eggs.

Lot No.	*Average number of eggs laid in a period of 7 days*	
C	247	(143—343)
T-1	277	(145—397)
T-2	273	(145—331)
DC	245	(220—312)
DT-1	287	(78—414)
DT-2	224	(165—405)

Figures in brackets represent the extent of variation met with in the individual flies of that lot.

DISCUSSION

The fact that X-rays in small doses lower and in higher doses completely destroy the normal activity of cells has long been noted by the majority of workers in radiation-biology. Bergonie and Tribondeau (1906) found that the sensitivity of the cells subjected to X-rays varies directly with their reproductive capacity (Bergonie—Tribondeau Law). Strangeways and Fell (1927) with the help of tissue culture methods and Ancel and Vintemberger (1924) working on Amphibian eggs and Packard (1930) working on Drosophila eggs, came to the conclusion that there is a definite relationship between sensitivity and metabolic rate. They found that the activity of the cells after exposure to X-rays determines to a great extent the degree to which the cells will be injured. If cellular activity after radiation is great, then the cells which are suffering from the effects of radiation are unable to perform normally these activities and as a result, abnormalities occur. On the other hand if cellular activity after radiation is slight, then the cells may be able to recover from the effects of the radiation and no serious disturbance may result.

In order to test whether or not a general reduction and a lowering of the egg output and rate results as a consequence of radiation, the egg records of flies were subjected to a statistical analysis. A cumulative 12 hr. record of eggs of all flies was taken starting with the first day of laying and ending with the 7th day. Cumulative egg records later than the 7th day were not computed as the X-ray effect wears off after 5 to 6 days. The figures for treated and un-treated sets were obtained separately. The mean egg out-put in each set for every 12 hr. period was then computed and the means thus obtained of treated and untreated flies comparedand tested forsignificance. Results are brought out inTableIII.

TABLE III

MEAN CUMULATIVE EGG RECORD IN TWELVE HOUR PERIODS

Periods	C	T-1	T-2	DC	DT-1	DT-2
1	32.7	11.0	15.1	3.5	14.0	13.0
2	39.0	13.0	16.2	17.0	18.7	14.2
3	62.2	37.9	36.2	35.0	43.0	37.9
4	65.8	42.0	43.8	56.5	66.6	56.1
5	89.7	86.9	69.9	81.1	89.8	80.2
6	94.3	91.1	73.3	101.5	112.3	97.1
7	126.8	113.9	106.8	122.0	136.5	126.6
8	147.0	135.3	127.5	146.0	162.4	143.8
9	161.3	164.5	150.4	168.1	185.7	166.4
10	180.7	181.7	176.8	193.1	217.0	192.1
11	192.7	203.1	192.4	208.7	235.3	211.9
12	210.0	232.2	219.4	225.9	260.4	227.6
13	229.0	244.0	226.8	240.9	272.8	220.5
14	247.5	276.8	252.4	244.8	287.4	240.5

A significant difference extending up to the first three periods in T-1 and another extending up to the first four periods in T-2 were obtained

in the flies of the non-dark series, whereas no such difference was noted in the flies of the dark series. If the significant difference in egg output that we observe in the non-dark series is really due to X-ray treatment, then we should have expected to get a more pronounced effect of that in the dark series, as the day and night influence is eliminated here—the flies laying approximately the same number of eggs during the night and the day. The absence of any such difference in the dark series makes us reject the possibility that the differences found in non-dark series are due to X-ray treatment. We believe therefore, that on the basis of the results obtained, there is no ground to conclude that a general retardation of the process of egg production follows the exposure of flies to X-rays of the kind used by us.

The fact that in this instance no lowering of egg output was observed, may in part be explained by the nature of the treatment we gave to the flies immediately preceding the exposure. We gave these flies a clear 36 hours feed on ripe bananas to ensure full development of their ovaries (The ovaries of the newly emerged female are sexually in an immature condition, unlike the testes of the new emerged male). Hence, we believe that the ovaries of the flies used in the experiment were not in an immature condition. In fact, looking to the negative results (as far as the lowering of the egg output is concerned) that we get and to the earlier finding of Strangeways and Fell (1927), Ancel and Vintemberger (1924) and Packard (1930), this belief of ours appears almost sound. It is because the ovaries were in a pretty advanced condition of maturity that the effect of X-rays was not so drastic, though we had used as high a dosage as 2400 r units. The type of X-rays used by us may also have influenced the results we got, though this is a point that will have to be further investigated. It also explains why so few steriles and abnormal layers we obtained.

We then come to the second part of our results : *viz.*, the finding of non-laying and abnormal egg laying females. The latter were seen only in the T-2 series, whereas the former not only occurred in the treated, but also in the controls. How are we to explain the presence of stunted and generally abnormal looking and sterile eggs in some flies and no eggs at all in the others ? Are these peculiarities produced by X-ray treatment ? Or were they already present in the stock of flies used ? These are the questions that will have to be considered.

The presence of one non-layer in the controls of the prelimnary experiment suggests the probability of the defect being already present in the stock. Whether the defect was due to genetic or non-genetic causes, we are not in a position to say, as we did not carry out any tests to verify this point. But, in view of the uniform experience of Drosophila workers in X-ray genetics, where they have obtained non-layers in treated flies, even though no such defect could be demonstratably shown either in the stock or controls, we cannot rule out the possibility of a few at any rate of the five non-layers we obtained in the treated series, as defects arising out of X-ray treatment. Here again, the nature of the defect *i.e.*, whether genetic or non-genetic, in the absence of clear evidence or tests to verify the same, would be a matter of conjecture. Is the complete sterility due to a change produced in the nuclear material or is it due to disutrbances caused in the normal functioning of cytoplasmic inclusions, as for instance

the Golgi bodies or both taken together? This would form a different problem for future investigation.

THE ABNORMAL LAYERS

Abnormal layers are found in the treated series only and do not occur like the complete steriles in the controls. Elsewhere in Drosophila, abnormal layers are usually associated with certain well known mutations of low viability. Attempts to isolate a factor for egg abnormality *apart* from the mutants met with no success. Lynch (1919) who studied the eggs of a number of mutant strains in Drosophila melanogaster failed to isolate any factor independent of the mutant itself that caused egg abnormality which made her conclude that the abnormal shape of the eggs is due to one of the manifold effects of the gene responsible for the mutation. Prabhu (1939) for the first time succeeded in isolating a factor, located on the III chromosme of Drosophila pseudo-obscura which was independent of any known mutants and affected the shape, size, fecundity and fertility of the flies. Analysis of the history of that stock from which the mutation was discovered showed that the flies came originally from an X-rayed culture. All these facts, taken with the complete absence of any abnormal layers amongst the controls, point out that X-rays were responsible for the production of abnormal layers. This effect in all probability is similar to the one in which there is a complete stoppage of egg laying, only it is of a mild character in the former and more drastic in the latter. The following explanation would solve the question why so few non-layers and abnormal layers were obtained, although such a high dose of 2400 r units was given.

The fully developed ovary of Drosophila is pear-shaped, with the ovarioles containing eggs in various stages of development mainly forming its body. The tip of the pear is directed towards the head and in this region very immature eggs and primordial egg cells are found. The rest and major portion of the ovary naturally is occupied by the eggs in various stages of development. The more mature eggs are away from the tip.

The ovary exposed by us to X-rays was of this type, as it was mature. The probability of the eggs in various stages of development being hit is greater than the tip containing the primordial egg cells. If one of the immature eggs is hit, and a change produced therein, only that egg will show the defect. If however one of the primordial egg cells is hit, then the whole string of eggs produced from it, will be defective. Now, as we found no single defective egg in the normal layers, it means that when such individual hits on eggs were registered, the state of the egg was far advanced to check its normal development. In other words, though a genetic change might have been produced in the egg (this change will be seen if dominant, only in the fly that will emerge out of that egg or if recessive, only in the progeny of such a fly), it was not strong enough to produce a drastic change in the shape and size of the egg. Whereas, if a hit is registered on one of the primordial egg cells, these cells being in a young, active and undifferentiated condition, the change produced there, will affect all the eggs arising out of it and hence you find an abnormal layer. If the hit is right on the tender cells themselves, then naturally no eggs will be produced and hence you get a sterile female. The con-

clusion that the number of sterile and abnormal layers obtained is determined by the state of the ovary at the time of exposure is being tested by using pupa and newly emerged females for X-raying and the results of that experiment will be published later. For the present we may conclude that X-rays of the kind used by us, do not retard the normal egg production, provided the ovaries at the time of exposure are in a highly developed condition. The sterile and abnormal layers obtained, represent the individuals which got the radiation right on their primordial egg cells.

SUMMARY

1. In an attempt to find out the effect of X-rays on egg production, Drosophila melanogaster, Race Kalyan females were exposed to X-rays using 90 K. V. peak, 12 cms target distance, 5 m. amp. current and a low filter. Two treatments were tried. In one (T-1) 800 r units were given; in the other (T-2) 2400 r units were given. Separate 12 hour period egg records of treated and control flies were maintained for 10 days.

2. Care was taken to see that the ovaries of the treated females were not immature at the time of exposure.

3. In the majority of the treated flies no significant effect on the rate of egg laying that could be traced directly or indirectly to X-ray treatment was obtained. A few flies were obtained that either laid no eggs or laid eggs of abnormal appearance.

4. At least a few of the non-layers and all abnormal layers are shown to be defects (genetic or non-genetic) produced in the flies by X-ray treatment.

5. An explanation is given for the absence of significant effects on the rate of egg laying following exposure to X-rays. An explanation is also given for the comparatively fewer non-layers and abnormal layers obtained in treated flies.

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LIST OF THESES

List of Theses in Botany, Zoology, Microbiology and Agriculture which have been accepted in lieu of the Examination for the Degrees of M.Sc. and Ph.D., from October 1942 to September 1943

Name of the Candidate	Title of the Thesis	Teacher	Place of Research
	M.Sc.		
	Botany—		
Bhate, P. D. ..	A contribution to the structure and life history of Finbriaria Augusta St.	Dr. T. S. Mahabale	N. W. C.
Deshpande, S. R.	Structure and life history of Plagiochasma Articulatum Kashyap: Liverwort Flora of Panchgani	Professor D. L. Dixit	F. C.
Gupte, K. R. (Mrs.)	Studies of the Species of Riccia (Mich.) and Notothylas (Soll) in the neighbourhood of Poona	Professor V. V. Apte	F. C.
Patel, R. I. ..	A contribution to the life history of Gloriosa superba Linn	Professor S. V. Shevade	B. C.
Patil, R. P. ..	A contribution to the study of the Stem-anatomy of Indian Climbing Plants	Professor J. F. R. d'Almeida	St. X.
Ramaswamy, C.S.	A contribution to the study of the Ecological Anatomy of the Indian Cyperaceæ	Professor J. F. R. d'Almeida	St. X.
	Zoology—		
Sarangdhar, P. N.	Selachian Fauna of the Bombay Waters with a note on Shark Liver Oils	Dr. S. B. Setna	Dept. of Industries, Bombay
Tulyani, M. H. ..	Early Development of Chelonia mydas	Professor P. R. Awati	R. I. Sc.
Varde, M. R. (Miss)	1. Echis carinata and its Anatomy; 2. Modification of the Trechea and Lung in some Indian Snakes; 3. Comparative Histology of the Lung of some Snakes	Professor C. J. George	W.
	Microbiology—		
Patwardhan, W. H.	Fate of Certain Pathogenic Organisms in the Purification of Sewage	Dr. V. R. Khanolkar and Dr. R. G. Dhayagude	Gor.
Vachha, M. R. (Miss)	Some Aspects of Microbial Sterilization of Fish	Dr. J. B. Bhat	St. X.

Name of the Candidate	Title of the Thesis	Teacher	Place of Research
	Agriculture—		
Deshpande, D. S.	1. Relation between Growth and Absorption of Nutrients by Plants ; 2. Decomposition of Molasses in Bombay Soils	Dr. J. A. Daji	Coll. of Agri.
	Ph.D.		
	Zoology—		
Kulkarni, C. V...	Osteology of Indian Cyprinodonts	Dr. S.B. Setna	Dept. of Industries, Bombay
	Agriculture—		
Talati, R. P. ..	1. Movements of Salts in Typical Soils of the Bombay Deccan Damaged Lands and their classification and Reclamation under Controlled and Field Conditions ; 2. Drainage and Reclamation of Waterlogged Lands in the Deccan and Suitability of Drainage Waters for Irrigation; 3. Tidal Land Survey in Gujarat and their Reclamation	Independent Work	....

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CONTENTS

RACHOL AND RAICHŪR

By

Professor G. M. Moraes,

St. Xavier's College, Bombay 1

IN his *Chronica dos Reis de Bisnaga,*[1] Fernao Nuniz has given a detailed account of the siege and capture of a fortified city called Rachol by Kṛishṇa Dēva Rāya, the Emperor of Vijayanagar. The late Mr. Robert Sewell, who in his *Forgotten Empire* has devoted considerable space to the description of this campaign and has once for all settled the date of this event as 1520 and not 1522 as stated by the Portuguese chronicler, had no doubt that the Rachol here referred to was Raichūr in the present Nizam's dominions,[2] apparently because the Raichūr doab had from the foundation of the rival Hindu and Muslim powers in the Deccan formed a bone of contention between them. This forthright identification had long been accepted without question till it was challenged by Rev. H. Heras, S.J.,[3] and though efforts have since been made to support the opinion of Sewell on grounds of geography and considerations of policy,[4] the contention of the former that "Rachol is for the Portuguese nothing else but Rachol, the fort city of the peninsula of Salsette," has not yet been met.

It must be said in fairness to Fr. Heras that in this he is not entirely without support from Portuguese sources. In his celebrated work *Promptuario das Difiniçõesi Indicas,*[5] Fr. Leonardo Paes describes Rachol as a fort in Salsette "surrounded on the one side by the river, and on the other by a trench," and goes on to say that it was handed over to the Portuguese by Kṛishṇa Dēva Rāya on the occasion of its fall to Vijayanagar :

> "The fortress of Rachol belonged to king Idalxa, when Crisna Rao, a descendant of the Emperor Rama Raza, marched against it with an army of 35000 horse, 733000 foot, 586 ele-

1 Ed. by David Lopes, 1897, Sociedade de Geographia de Lisboa.

2 Sewell, *A Forgotten Empire*, pp. 137-160.

3 Heras, "Krishna Deva Raya's Conquest of Rachol," *Journal of the Royal Asiatic Society*, 1931, pp. 142-47.

4 Ramachandrayia, "'Rachol'—Its Identification," *Proceedings of the Indian History Congress*, IV session, pp. 284-289.

5 Fr. Leonardo Paes was a Goan. He describes himself on the title page of this work which was published in Lisbon in 1713, as a descendant of the Kings of Sirgarpor, Vicar of the Church of St. Thomas in the City of Goa, Protonotary Apostolic and Notary to His Holiness. He seems to have been a Master of Arts, or "Licenciado" of the Jesuit University of St. Paul, in Goa, since he calls one of the Jesuit Professors there his "amantissimo mestre" or beloved *guru*. This work, full of abstruse learning, was meant to be a rejoinder to Fr. Antonio João de Frias, who in his *Aureola dos Indos e Nobiliarchia Bracmana*, sought to defend the superiority of the Shenvis of Goa over the ruling class, the Kshatriyas. The *Promptuario* and the *Aureola* were most probably the earliest known works by Indian writers in a European language.

phants each carrying in its castle 4 men, 12000 water bearers, and numerous baggage ; though he received heavy losses from the soldiers of Idalxa at first, he succeeded in reducing them to misery, and with the fall of the fortress he took 4000 horses, 100 elephants, 400 large cannon and a great many small ones besides immense riches. When a captain of the Idalxa appeared before him asking him to restore the booty, he offered to return the whole of it if his king came to him and kissed his feet as sovereign lord of the Empire of India. At length he handed over the said fortress to the Portuguese at the time when Lopez de Sequeira was the Governor of this State, as mentioned by Faria and by Goes, and confirmed by Fr. Frey Francisco Negrão, who in his accounts of this city is clear on the matter of this transfer."[1]

We confess to our ignorance of Fr. Negrão, the last named author, but as to the learned Fr. Paes himself it must not be forgotten that he wrote in the eighteenth century long after the fall of Vijayanagar and therefore could not have commanded the knowledge of earlier writers to whom on account of the intimate relations subsisting between the two powers, the places in the Deccan were familiar. That his knowledge of Vijayanagar is slight is obvious from the mistake he commits in calling Kṛishṇa Dēva Rāya a descendant of Rāma Rāya. It is therefore necessary that we should scrutinize his sources and see how far they bear him out.

Faria y Sousa may be taken first not so much because he is an original source as because both Fr. Paes and Fr. Heras depend for much of their information on him. In the passage quoted above the former is so true to his original that he lifts entire sentences out of the Spanish text of the *Asia Portuguesa* and renders them into Portuguese. But Faria y Sousa published his work as late as 1674, and according to a competent authority[2] his first two volumes are a rehash of early historians like Barros and Couto. Significantly enough Faria y Sousa does not support Fr. Paes in his assertion that Rachol was handed over to the Portuguese by the Vijayanagar Emperor. He merely says "Ruy de Mello who was in Goa, seeing that the Hidalcan was distracted by his losses, or by his hopes, or by both and that others in partial differences were robbing the mainland in the vicinity, conquered it easily with 250 horse and 800 Kanarese infantry."[3] The conclusion is evident that Ruy de Mello seized the opportunity to capture the Konkan, while the Sultan was embroiled with the Emperor elsewhere in his dominions. For had the battle been fought in Salsette, he would not have been able thus to possess himself of the country, which would then have been in the occupation of Vijayanagar. Clearly, the Rachol of Faria y Sousa is not the one of Salsette.

Nor does Faria y Sousa support the contention of Fr. Heras from which the latter deduces an important consequence. He says, "From the Spanish original of this author it may be easily gathered that the intention of Figueredo was to proceed to Vijayanagar; and it was only after

[1] Paes, *op. cit.*, pp. 72-73.

[2] Whiteway, *The Rise of Portuguese Power in India*, p. xiv.

[3] Faria y Sousa, *Asia Portuguesa*, I, p. 196. I am indebted to Fr. Heras for the elucidation of this obscure passage.

leaving Goa that he heard of the king's proximity while besieging Rachol."[1] Referring to the *Asia Portuguesa*, we read : "*Agora buelve et vitorioso Crisnarao la frente airada a la ciudad, quando le aparecen viente Portugueses de que era principal Cristoval de Figueredo, que de Goa llevava algunos cavallos Arabes para vender al proprio Rey.*"[2] Even granting that his original intention to proceed to Vijayanagar is implied in this passage, Figueredo could, as he actually did, change his course on hearing on the way that the king was absent at Raichūr. Then again, it is unlikely that Figueredo should have come to know, as Fr. Heras supposes, of "the king's proximity while besieging Rachol" only after leaving Goa. For, on Faria y Sousa's own showing, Kṛishṇa Dēva Rāya had besieged the town already for three months, and had under its walls inflicted a disastrous defeat on the Sultan who had come to its relief; and moreover for an important battle like this fought in the presence of two sovereigns not to be bruited about in the streets of Goa, apart from other channels of information open to the Government such as espionage, it must have taken place not at Rachol which is only at a few hours' distance up the river from the capital, but at Raichūr, which is "further from Goa than Vijayanagar itself."[3]

Barros is even more explicit, and leaves not a shadow of doubt as to the place meant by the chronicler. For the siege of Raichūr and the battle that followed it Barros is dependent on Nuniz, but he has based his account of the acquisition of the mainland on other authorities, possibly the papers in the state archives of which he was the custodian. He relates :

> "Among the people who inhabited the districts and lands in the neighbourhood of Goa there were two families of ancient lineage. All these *Tanadarias* came under the control of these chieftains until they were wrested from their hands by the Muslims. One of these families was called Beras, and was ranked superior to the other, which was called Gijs. Two brothers belonging to the latter, Comagi and Appagi, seeing that the Hidalcão, badly beaten by King Crisna Rao, would not be able to defend the territories on the seashore from the mountain ranges to the plains below, which belonged to them, collected about 8000 men and slowly driving the Muslim garrisons from the lands in their occupation, at length came to and attacked the *Tanadarias* . . . which was the headquarters of the Muslim Captain of the Hidalcão.
>
> "This captain, desirous of turning to his own account the defeat of his master, decided to angle in the troubled waters and to keep for himself a part of the revenues collected from these lands. With this object, he represented to Ruy de Mello that he suffered much harassment from the rebel Hindus who were going about the country committing depredations so that the provisions which usually came to the city of Goa could

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[1] Heras, *art. cit.*, *J.R.A.S.*, 1931, p. 144.

[2] Faria y Sousa, *loc. cit.* "And now the victorious Crisna Rao turned himself in elation towards the city, when there appeared twenty Portuguese headed by Cristoval do Figueredo, who were bringing some Arab horses from Goa to sell to the King himself."

[3] Heras, *loc. cit.*

not be sent. In view of the peace and commerce existing between him and the Hidalcão, the captain begged of Ruy de Mello as a good neighbour and friend to assist him with some men against these thieves who had already caused so much damage while the Hidalcão, thanks to his differences with the King of Bisnaga, delayed succour. While his help would serve as some impediment, he could proceed to wrest these lands from the Hindus, which on account of the small number of troops at his command he dared not defend at present. For this purpose he should exert himself and help him as best he could ; since he knew the mind of the Hidalcão, his master, who would rejoice to see these territories in the hands rather of the Captain than of the Hindus.

"Ruy de Mello then took counsel with the chief men in the city (since D. Aleixo de Menezes, who had been charged with the Government of India by Diogo Lopes, was at this time wintering at Cochin), and it was agreed that with some honest excuse he should put off assisting the Moor. As for the seizure of the *Tanadarias,* inasmuch as time and circumstances appeared propitious, and the cost negligible, he should accept the offer and march on them immediately. When the Moor was apprised of the decision he was pleased with it, since nothing seemed to abet his plans better.

"Ruy de Mello easily forced an entrance at the head of a posse of 250 horse and 800 Kanarese sepoys. He took the chief *Tanadarias* within as brief a space as ten or twelve days, and left there Ruy Jusarte as Captain of the field with some horse and infantry. When they saw that they had to fight with us, now that Ruy de Mello had betaken himself there, the Hindus with commendable prudence abandoned these territories and went scouring the sea-coast as far as Chaul . . . . And they were prosperous for four years consuming the revenues despite the Hidalcão.

"The Moorish Captain who so wove this web as to place us in possession of the *Tanadarias* of Goa, fled to the city for fear of the Hidalcão since he had failed in his duty to defend his lands. He desired to preserve what he had robbed, and was confident that honour would be done to him in Goa for his services."[1]

There can thus be no doubt about the Rachol of the original authorities like Nuniz and Barros. Further elucidation is furnished on this point by Fr. Giovan Pietro Maffei, the Italian Jesuit, who though he takes Barros for his guide, clears the ambiguities in the latter.[2] According to him, as a result of his defeat at Rachol, Ādil Shāh

"lost his reputation in his distant territories, where fortunately Crisna Rao could not arrive with his armies. And on

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[1] Barros, Decadas, III, bk. iv, ch. v, pp. 438-441. (Published between 1552-63).

[2] Father Joseph François Lafitau, a French Jesuit who wrote in the thirties of the XVIII century, closely follows these authors in his *Histoire des Decouvertes et Conquestes des Portugais,* Vol. II, pp. 342-345.

> the news of the rout having spread, some of his subjects broke into rebellion, especially the Gini, who were well known in the kingdom of the Deccan. Two brothers Como and Apa, princes of this family, having assembled about 8000 people rushed into the field. They had taken shelter in the Ghauts, undoubtedly with the intention of descending thence upon the sea-coast (the country is called Concan, and borders on Goa) . . . . . which had long since been wrested by Muslims from the Gini."

An account follows of the Governor of these places who wished to defraud his master Ādil Shāh of the revenue, and finding the city of Goa a convenient place of retreat, made friends with the Governor, and under the pretext of calling in his aid,

> "freely persuaded him that he should by preference occupy these ports and towns in the name of King Emanuel, because the Idalcão would fain have the wealth and revenues come into the power of the Portuguese rather than into that of his rebel subjects."[1]

As it will have been noticed, both Barros and Maffei deliberately avoid any mention of the donation of the *Tanadarias* of Goa to the Portuguese King by Kṛishṇa Dēva Rāya. Castanheda, who was the first to give currency to the story says that it was a sort of a *quid pro quo* for the monopoly of Arab steeds, demanded by the Emperor.[2] And no doubt, it was because of this circumstance which made it look plausible, that he was followed by later writers like Correa[3] and Goes.[4] In rejecting this account Barros and Maffei must have relied on documents in the archives which gave altogether a different version.

That the story is a myth is also evident from the subsequent relations between Vijayanagar and Goa. Two newly discovered inscriptions from North Kanara refer to hostilities between the Portuguese and Immaḍi Dēva Rāya the Sāḷuya feudatory of Vijayanagar, ruling from Gersoppa, in 1522, when he invaded Salsette, and met the "Kapita Mohara" (Capitão Mor) of the Parangas (Portuguese) of Goa at Maḍagōve or Margão.[5] This seems to be a part of the organized attempt of Kṛishṇa Dēva Rāya to regain his lost territories in the Konkan.[5a] For in the following year these territories were again invaded, though unsuccessfully, by Sāluva Timma, his minister.[6]

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1 Maffei, *Le Istorie delle Indie Orientali*, pp. 279-281. (1589)

2 Castanheda, *Historia do Discobrimento e Conquista da India*, Bk. V., ch. 57, p. 90.

3 Correa, *Lendas da India*, II, p. 581.

4 Goes, *Cronica de D. Manuel*, pt. IV, p. 145.

5 Panchamukhi, *Karnatak Inscriptions*, Vol. I, pp. 165-9.

5a Konkan had been conquered from Vijayanagar by Mahmūd Gāwān in 1472.

6 Barros, as in Sewell, *op. cit.*, p. 158. (The reference to Barros does not tally). After this article had gone to press, I found the passage under reference in the next volume, and also that Saluva Timma's campaign had actually preceded that of Gersoppa under the leadership of "Caro Ponaique, a nephew of the king of Gersoppa with the title and inheritance of the lands that belong to him." Caro Ponaique is here described as a 'captain of the king of Bisnaga.' This, however, does not disturb my thesis.

But it is a mistake to think that even Castanheda and the writers who follow him imply that the Rachol they speak of was the one in Salsette.

> "When these events were taking place in Ormuz," writes Castanheda, "in India the Hidalcão was about to come and lay siege to Goa with 600,000 men both horse and foot, and 100 large guns, intent on capturing it. But Our Lord wished to help us in this crisis, and (permitted) a war to break out between the Hidalcão and the King of Narsinga. The former was defeated in battle with heavy losses and fled from the field. After this victory the King of Narsinga pursued him and seized the cities of Rachol and Bilgão, and many others besides, as a result of which the *Tanadarias* on the borders of Balagate, in the vicinity of Goa remained unguarded."[1]

It is thus clear that Ādil Shāh's intention was to avail himself of the absence of Diogo Lopes, the Governor, at Ormuz, and of the reverses he had suffered before Diu[2] to oust the Portuguese from their new possession which had been the brightest jewel in his crown. Krishṇa Dēva Rāya, when he heard of this, created a diversion, not so much from a love for the Portuguese as from the motive which Goes correctly attributing to him says,

> "On account of the hatred which he bore to the lords of this province of Balagate and for fear that if Goa were to fall to Idalcão it would besides adding to his power, prevent Vijayanagar from importing the horses of which she stood in sore need."[3]

Lastly, the story of the donation cannot be utilised to support the thesis that the Rachol of the Portuguese chroniclers was the Rachol of Salsette. For Castanheda himself says that in calling upon Ruy de Mello to take possession of the lands Krishṇa Dēva Rāya believed that he could make a present of them to the King of Portugal, since "he had taken Bilgão by force of arms from the Hidalcão, *with all the lands appertaining to it as far as the sea*" (italics mine).[4] The inference therefore is unwarranted that in order to make this donation, Krishṇa Dēva Rāya "must have secured possession of Salsette" by his capture of Rachol.[5]

1 Castanheda, *loc. cit.*
2 Whiteway, *op. cit.*, ch. IX.
3 Goes, *loc. cit.*
4 Castanheda, *loc. cit.*
5 Heras, *art. cit.*, p. 146.

THE NEAR EAST AND THE INDUS VALLEY

An Introductory Comparative Study of Prehistoric Ceramic Art

By

P. JOSEPH, B.A.,

St. Xavier's College, Bombay

THE ceramic history of old cultures presents so many important points of comparison that the student finds it absorbingly interesting. The extensive and intensive excavations carried on in the West have reduced the study of ceramics almost to an exact science. Although the same cannot be said of India, yet the materials so far available can at least be made to correlate with the Western finds ; and thus the beginnings of a scientific Indian ceramic study can be indicated. Such a start has been made by the excavators of the Indus Valley sites, like Marshall, Mackay and Majumdar.

In Mesopotamia the study of prehistoric pottery[1] has given us definite stages of pre-dynastic culture. In the south the earliest stratum was Al Ubaid, marked by a pottery painted with black geometric designs on red slip or wash. It was followed by the Uruk period, characterized by plain grey, black and specially red ware. Its provenance was Anatolia and Transcaucasia. During the same period we find also another kind of pottery called reserved slip ware, whose centre of dispersion seems to have been North Syria. The Uruk stage was followed by the Jemdet Nasr period distinguished by polychrome pottery painted almost wholly with geometrical designs in three colours, generally red, black and white. In Northern Mesopotamia the earliest period was marked by neolithic finds. Later came the Halaf-Samarra stage, the former part of the compound name standing for polychrome ware completely geometrical in pattern and the latter for ware with Al Ubaid affinities. All these various stages except the earliest in Northern Mesopotamia belonged to the Chalcolithic Age.

In Persia[2] excavations at Susa have shown that the earliest culture was Chalcolithic. It is called Susa I and its pottery is akin to that of Al Ubaid, but with more animal designs. Susa I was earlier than Al Ubaid for the latter ware lay above the former at Susa. The Uruk and the Jemdet Nasr stages also flourished at Susa, and they were followed finally by a stage known as Susa II, with monochrome pottery showing a definite bias towards animal and plant designs executed in a style absolutely different from that of Susa I.

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[1] The best attempt so far made is perhaps that of Dr. Frankfort in his *Archaeology and the Sumerian Problem.*

[2] Frankfort, *op. cit.*, pp. 65-69. Childe calls the strata preceding Susa II, as Susa I, *a*, *b*, c and *d*. (Childe, *New Light on the Most Ancient East*, pp. 232-249).

In India stratigraphy leaves us in the lurch. About 50 places have been surveyed and less than half a dozen excavated with any pretence to systematic endeavour ; and in not one has virgin soil been yet reached. These stupendous barriers can hardly be surmounted in the quest for any coherent stratigraphical results. Hence the attempts, although laudable, of Mr. Majumdar cannot completely carry conviction. They were the outcome of an extensive and exploratory endeavour over a large tract and not of an intensive nature to justify unerring stratigraphical conclusions. Yet the tentative stages he has given us do serve, while awaiting full confirmation, as beacon-lights in the dark path of Indian prehistoric archaeology. The earliest stage so far discovered is Amri, distinguished by bichrome pottery wholly geometric in design. It was followed by the Harappa stage characterized by two kinds of pottery : black on red monochrome ware with animal designs typical of Susa II, and above it plain red ware. Then came the Jhukar epoch marked by bichrome pottery of a new type with plant and animal designs. At last appeared the Jhangar stage with incised black ware.

Even a casual glance at these wares makes one realize that the greatest resemblance exists between the Indian monochrome pottery and that of Susa II. This similarity may, therefore, provide us with a starting point for the comparative ceramic study. The Indian and Susian pottery show a likeness, specially in designs and the way they are executed.

For a proper understanding of the comparison we ought to know what makes the styles of Susa I and II differ from each other. Susa I style was idealistic,[1] while Susa II was realistic.[2] Whereas the Susian ancestor soared into the dreamy heights of abstract conception, his successor descended to the *terra firma* of cold reality.

The difference in style is well illustrated in the treatment of animals. The one animal whose design is found to any large extent in the pottery of Susa I is the ibex. Its peculiar treatment can be noticed in the use of straight lines to depict its body; and the *raison d'etre* of such depiction is to be seen in the prevalence of numerous srictly geometric patterns that adorn the pottery of Susa I. Hence even when an animal is introduced into the midst of geometrical patterns, it has to be rectilineal in shape. The same ibex is seen in the pottery of Susa II, but how differently drawn ! Its body is well delineated and pose dynamic. One sees the ibex here, while in Susa I one feels it is there. The difference in treatment we have just noticed is responsible for yet another. While the body of the animal is filled in black in Susa I,[3] it is cross-hatched in Susa II.[4]

The styles of Susa I and II are so different that by no stretch of imagination can we conclude that the latter had its origin in the former. The latter's provenance has got to be discovered elsewhere ; and since it is not found in Mesopotamia but is widely prevalent in the East, *a priori* it would appear that we should look there for its birth.

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[1] Carleton, *Buried Empires*, pp. 36-37.

[2] Frankfort, *op. cit.*, p. 69.

[3] *Memoires de la Delegation en Perse*, XIII, Figs. 121 and 132.

[4] Frankfort, *op. cit.*, p. 70 ; *Memoires de la Delegation en Perse*, XIII, Figs. 139 and 144.

Another circumstance forces us to look to the East for the distinctive style of Susa II. That is the occurrence of the humped bull in Susa II. Like the ibex it is delineated in an absolutely naturalistic pose and its body cross-hatched.[1] The discovery of the bull in relief on some of the asphalt vases of this period[2] coupled with its earlier appearance on painted pottery[3] of the same period is very significant. To the same period too belong the terracotta figurines of the humped bull.[4]

In the East the trial excavations of Sir Aurel Stein in the province of Fars or the ancient Persis have yielded neither pottery with the bull design nor bull figurines. Their absence is also noted in eastern Persia, except for a bull figurine found at Bampur.[5] But further east their presence is very conspicuous.

The bull is found commonly depicted on the pottery of Baluchistan and Waziristan. Kulli,[6] Mehi,[7] Sāka-Kalat[8] and Nāl in[9] Southern Baluchistan have produced such pottery in quite large quantities, while at Periano-ghundai[10] in Northern Baluchistan and at Chīcha-Dērai[11] on the Waziristan border it is also to be met with. To the pottery depictions we may add the large amount of bull figurines recovered from several sites. Taking the Southern Baluchistan sites first, we find that at Kulli in one trench alone—Trench V—were picked up 66 figurines.[12] Mehi yielded 199 fairly preserved figurines, while innumerable ones were too broken to be worth gathering.[13] At Shahi-tump about 85 were found.[14] Among others we may note one at Mammai-damb in the Besema tract,[15] another at Saka-kalat,[16] one more from a hillock just outside Nāl village,[17] half a dozen at Siāh-damb of Jhau[18] and numerous fragments from the mound of Nokjo Shāhdīnzai.[19] In Northern

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1 Yet another design appearing on the pottery of Susa II is the hachured leaf called the ovolo.

2 *Memoires de la Mission Archaeologique de Perse*, XIII, Pl. XXXIV, Figs. 5 and 6.

3 *Ibid.*, XX, p. 109, Fig. 11.

4 *Ibid.*, p. 110, Fig. 13.

5 Stein, *Archaeological Reconaissances in North-Western India and South-Eastern Iran*, p. 108.

6 *Memoir A. S. I.*, No. 43, Pl. XXI, Kul. I. i. 6 , Pl. XXII, Kul. V. iii. 1; Pl. XXIII, Kul. viii. 1.

7 *Ibid.*, Pl. XXVIII, Mehi. I. 1. 6 and I. 7. 2 ; Pl. XXIX, Mehi. III. 1. 1 ; Pl. XXX, Mehi. II. 4. 5, Mehi. III, 8. 1, Mehi. III. 4. 8 a, Mehi III. 1. 6. 3, and Mehi. IV. 1. 1.

8 *Ibid.*, Pl. XXXIII, Sāka. 1.

9 *Ibid.* , Pl. XXXIII, Nal. 13.

10 *Mem. A. S. I.*, No. 37, Pl. V. P. Sw. 34.

11 *Ibid.*, Pl. II, Ch. D. 10.

12 *Ibid.*, No. 43, p. 125 ; for specimens *cf. ibid.*, Pl. XIII, Kul. I. ix. 9 ; Kul. V. i. Kul. V. ii. 2 ; Kul. V. iii. 3 ; Kul. V. iii. 4 ; Pl. XXII, Kul. 14.

13 *Ibid.*, p. 161 ; for specimens see *ibid.*, Pl. XXXI, Mehi. I. 1. 34 ; Mehi. I. 2. 16 ; Mehi. II. 3. 1. a ; Mehi. III. 4. 8 ; Mehi. III. 7. 2.

14 *Ibid.*,p. 91 ; *cf.* also Pl. XIV, Sh. T. ii. 10, 14, 15, 16, 17 ,and 19.

15 *Ibid.*, p. 30.

16 *Ibid.*, p. 166.

17 *Ibid.*, p. 169.

18 *Ibid.*, p. 136.

19 *Ibid.*, p. 153.

Baluchistan bull figurines were recovered from the site of Periano-ghundai[1] and in Waziristan from the mound of Chīcha-Dērai.[2]

These examples show clearly the popularity of the humped bull in Baluchistan and Waziristan as a pottery design and as a cult object. Can we trace it farther east? The trial excavations of Mr. Majumdar along the Indus basin have shown us that we can. Pottery with the humped bull painted on it was found at Ghazi Shah[3] and Pandi Wahi,[4] while bull figurines were picked up from various places like Amri,[5] Lohumjo Daro,[6] Lakhiyo,[7] Mashak[8] near Shah Hasan, Ghazi Shah,[9] Gorandi[10] and Ali Murad.[11]

The humped bull is certainly indigenous to India, where to this day it has maintained its eminent place in the Saivite cult, which is one of the oldest of Indian cults, as definite evidence of it is found at Harappa, Mohenjo Daro and Chanhu Daro, the places where systematic excavations have been undertaken to any appreciable degree. Although in these places pottery with the humped bull design has so far not been discovered,[12] yet bull figurines have been found in large numbers. Moreover, the animal is depicted on the Indus seals so commonly that one feels it is typical of Indian fauna. That its cult spread over the whole of the Indus Valley is established beyond the shadow of doubt by the trial excavations of Mr. Majumdar.

In view of the fact that the bull has a very long religious history running right up to the proto-Indian Age, it will not be going beyond our premises to conclude that the cult had its origin in India and travelled towards the west. Rightly did Sir Aurel Stein surmise that the cult of the bull figurines he found in his wanderings pointed to India as the home of its origin.[13]

Just as the bull is delineated in all its natural grandeur on the Indus pottery, so is the ibex. There is some doubt whether the animal depicted on the Indus seals and pottery is the Persian ibex or the Indian wild goat, native of Kashmir. If we take the animal to be the former

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1 *Mem. A. S. I.*, No. 37, Pl. VII, P. Sw. C. 6; Pl. VIII, P. C. 1.

2 *Ibid.*, Pl. II, Ch. D. 1.

3 *Ibid.*, No. 48, Pl. XXVI, 8, 17 and 22; Pl. XXVII, 26.

4 *Ibid.*, Pl. XXVIII, 17, 18 and 24.

5 *Ibid.*, pp. 26, 33.

6 *Ibid.*, pp. 51, 54, 58.

7 *Ibid.*, p. 68.

8 *Ibid.*, p. 73.

9 *Ibid.*, p. 85.

10 *Ibid.*, p. 88.

11 *Ibid.*, p. 91.

12 The reason for it is to be found in the fact, amply proved by stratigraphy, that the earliest of the Harappa, Mohenjo Daro and Chanhu Daro remains compared with those of other Indus Valley sites and of Baluchistan reveal a cultural stratum that is definitely later. The preponderant pottery is unpainted, and the painted potsherds recovered evidently belonged to a stage that was fast going out of existence; and hence as they are not quite representative of the black on red monochrome ware that preceded the plain red ware it is not surprising that the few specimens of the former pottery found at the sites under discussion do not reveal the bull design.

13 *Mem. A. S. I.*, No. 43, pp. 92, 161.

it is foreign to India ; and as such its origin must be sought in Persia, where it is supposed to be indigenous. Yet its treatment on Indian Pottery is certainly unlike that on Susa I and akin to that on Susa II. The realistic treatment that the ibex received in India after it had penetrated its frontiers is something thoroughly foreign to Persian artistic standards. With that realistic treatment the ibex retraced its steps to its homeland and entered into the pottery style of Susa II, after leaving ample traces on the way in Baluchistan and eastern Persia.

True, there is introduced some conventionalism into the treatment of the ibex. But that seems to have been a development emanating out of realistic or naturalistic delineation. Since convention connotes a state of degeneracy we find the conventional mode of painting the ibex more in Baluchistan and east-Persian ware than on the Indus ware ; and no wonder, because naturalism having had its origin in India degenerated on its way to the west in Baluchistan and beyond to conventionalism. Even some stratigraphical evidence seems available to strengthen our point, since at Bampur the lower layers have yielded pottery with the realistic ibex, while the upper layers, pottery with the conventionalized ibex.[1]

We may conclude this discussion with a few words on some corroborative evidence to prove that realism was the special characteristic of proto-Indian art. Apart from the pottery style, which we have so far dealt with, sculpture too points to realism as pervading the artistic notions of the Indus Valley dwellers. The stone torso discovered at Harappa, which Marshall at once called Greek and after proper examination found it to be absolutely different,[2] provides us with a clue to the prevalent artistic mode. The body is well-formed, even muscular, giving the idea of the Greek idealistic type to the unwary critic ; but the scrutiny of the well-shaped abdomen compels him to descend to the realm of reality, of nature as it is commonly seen. There is nothing of the abstract in that statue, nothing of idealistic perfection, but everything to remind one of a real man with all his imperfections down to even the ugly protruding abdomen. And the result is not a lifeless something that exists nowhere except in the artist's mind but the portrait of a person fully endowed with energy and vitality. We may refer also to the other Harappa stone torso, showing a dancing pose. The well-shaped trunk and legs approximate as closely to dynamic nature as possible.[3]

Perhaps the bronze dancing-girl is better for our purpose. Her frail body, her alluring pose, her slightly inclined head, her elaborately dressed hair, her right arm akimbo, her innumerable bracelets, her daring nudity and her thick pouting lips, that seem to be full of loathing for a society which has condemned her to serve it in no honourable way—all vividly portray the inner affections of one who would like to and yet cannot get out of a life with a social stigma attached to it, and who, hence, disdainfully sticks to it, determined to face the situation with contemptuous coolness.

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1 Stein, *op. cit.*, p. 108.

2 Marshall, *Mohenjo Daro and the Indus Civilization*, I, pp. 45-47.

3 *Cf.* Heras, *The Origin of the so-called Graeco-Buddhist School of Sculpture of Gandhāar J.B.B.R.A.S.*, (N. S.), pp. 90-92.

In the mute animal world too this realism is evident. To choose one example only, the bull that is found carved on many seals is cut not merely with such a precision of detail with regard to body perfection as would do credit to any Greek artist but—what is more important—with such vitality and dynamism as would be beyond the capacity of the same artist.[1]

From the foregoing discussion it is absolutely clear that the artistic style of the Indus Valley was realism. It was realism that concentrated not merely on physical perfection but more on the inner affections of the objects under study. It would perhaps be better, therefore, to call the style spiritualistic realism.[2]

Having had such a highly developed realistic art as has been so far discussed it is no wonder that the Indus Valley dwellers showed it in the animal portraiture of their ceramic wares. Once it is realized that this particular ware was monochrome, painted in black on red slip or wash—exactly the same as Susa II ware—and that India was the home of that style and that nowhere else in the West it was found, then the conclusion is patent that Susa II style had its origin in the East, most probably in India.

As for the other wares one may feel tempted to compare the plain red pottery of the Harappa period with Uruk or Anatolian ware. But apart from colour they are so different in type that there is no possibility of their being connected. Moreover, the Indian red ware is in shape so similar to the black on red pottery, that preceded it,[3] that the conviction grows on our mind that the same people who were responsible for the monochrome ware, seem, in a utilitarian mood, to have decided to give up painting altogether in favour of plainness.[4]

Another type of Anatolian ware seems to have its counterpart in Baluchistan and eastern Persia. It is the spouted ware, which sometimes is seen with a beak-spout and is known as the *schnabelkanne*. A strain of such ware may be noticed in the spouted monochrome Al Ubaid specimens found at Ur[5] and Al Ubaid[6] by Woolley. Although it does not seem to have been popular in southern Mesopotamia, it is found in Persia as far south as Nihawend and in Turkestan as far east as Anau.[7] The distribution of the spouted ware shows that from its centre of diffusion in Anatolia and Transcaucasia it penetrated south and east. The east-Persian remains are known from Damba-kōh,[8] and the Baluchistan ones from Jiwanri[9] and Zangian.[10] Some of these

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1 Marshall, *op. cit.*, I, p. 43; *cf.* Heras, *op. cit.*, p. 92.

2 Heras, *op. cit.*, p. 78; Joseph, *Indian Art through the Ages*, *Bombay Chronicle*, Sept. 1, 1940.

3 Frankfort, *op. cit.*, p. 25, n. 2.

4 *Mem. A.S.I.*, No. 48, p. 150.

5 Woolley, *Excavations at Ur, 1929-30, The Antiquaries Journal*, X, Pls. XLIV and XLV.

6 Hall-Woolley, *Ur Excavations, Vol. I, Al Ubaid*, p. 159 and pl. LII.

7 Frankfort, *op. cit.*, pp. 32-39, 57-64, and Table III.

8 Stein, *op. cit.*, Pl. III, Dam. II. vi. 75; Dam. III, xi. 104.

9 *Mem. A. S. I.*, No. 43, Pl. IX, Ji. III, xvi. C; Ji. III. LXXVI.

10 *Ibid.*, Pl. XI, Zang. II. v; Zang. II. viii; Zang. I. xiv; Zang. II, xiv. a.

are painted in monochrome, which peculiarity seems to have been as much an indigenous influence in the Baluchistan as in the south-Mesopotamian, Hittite and Cretan types[1] of such ware. More systematic excavation would show whether or not the spouted ware penetrated the Indus Valley.

In this connection we may consider the reserved slip ware of Syrian origin that found its way into southern Mesopotamia in the Uruk period. Specimens of such ware have been found associated with the so-called Harappa stage of the Indus culture. This kind of pottery has so far not been encountered in eastern Persia and Baluchistan ; and in the absence of a more thorough search it would be hazardous to connect Mesopotamia and India on the score of the reserved slip ware.

As for the Jhukar ware affinities with the West have been perceived by Mr. Mackay. According to him in the motifs and the way the black and red colours are used on the cream or pink slip this bichrome ware resembles the Halaf ware discovered at Tell Halaf[2] and Tell Chagar Bazar.[3] The Jhukar painted designs, specially the chevron pattern, are all found in later Halaf ware. The similarity extends to the broad horizontal bands used in order to separate the registers.[4] These designs do not at all appear for the first time in Jhukar ware. The chevron and the red horizontal band can be traced in Amri bichrome ware, the earliest so far known in the Indus Valley. Although in shape the Jhukar ware brings in new types,[5] yet old types known in the preceding black on red monochrome pottery persist too in the Jhukar Age. The typically Jhukar designs, *viz.*, cross-hatched eye-shaped motifs in a row, eye-shaped compartments with a ball in each, concave squares alternating with balls, and a row of cross-hatched triangles with concave base, do not occur in Halaf ware. In view, therefore, of the continuance of old shapes and old designs and of the total absence of typical Jhukar motifs in Halaf pottery it would appear, in the present state of evidence, a little too bold to postulate that Jhukar ware represents an innovation introduced by a new people with new ceramic ideas rather than a development or, should we better say, decay of old ceramic notions.[6]

The last phase of ceramics in the Indus Valley, namely, the Jhangar pottery is characterized by incised patterns. Such designs already appear towards the end of Jhukar.[7] Incised ware is found in

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1 Frankfort, *op. cit.*, Table III.

2 Oppenheim, *Tell Halaf.*

3 Mallowan, *The Excavations at Tall Chagar Bazar, and an Archaeological Survey of the Habur Region, 1934-35, Iraq*, III, pp. 1-86.

4 Mackay, *Excavations at Chanhu Daro by the American School of Indic and Iranian Studies and the Museum of Fine Arts, Boston : 1935-36, Bulletin of the Museum of Fine Arts*, XXXIV, No. 205, pp. 84-86.

5 It must be noted that while at Harappa and Mohenjo Daro the monochrome painted ware was followed by plain red pottery, at Chanhu Daro, Jhukar and other sites in Sind it was followed by Jhukar bichrome ware.

6 Recently a noteworthy attempt has been made by Mr. Srikanta Sastri (*Proto-Indian Ceramics, The Indian Historical Quarterly, XVI, No. 3*) in the field of pre-historic pottery. The basis, however, *viz.*, the resemblance between Jhukar and Tell Halaf wares and ergo their contemporaneity, seems rather too slender to erect on it with any confidence the vast structure of proto-Indian chronology.

7 *Mem. A.S.I.*, No. 48, p. 154.

Baluchistan too.[1] Although incised designs appear in Mesopotamian pottery, as for instance, in the earliest plain ware at Al Ubaid[2] and in the remains lying on virgin soil and other levels at Tell Chagar Bazar,[3] yet materials are too meagre for us to see in the present case any connections between east and west.

It will be of interest to know if these ceramic resemblances can help us in the chronology of the Indus culture. For some time typical Indian square seals with Indus pictographs were known from Ur and Kish and they were discovered in strata assignable to 3000-2500 B.C.[4] The first comprehensive attempt, however, was made by Frankfort on the evidence found by him at Tell Asmar of typical Indian ware—namely, knobbed pottery—and of cylinder seals most probably of Indian workmanship and depicting certainly Indian animals. The learned doctor, whose archaeological methods are flawless, is for a date around 2500 B.C.,[5] for the finds were recovered from a house of the Dynasty of Akkad. His subsequent work at Tell Agrab has enabled him to go a bit earlier, for in a temple assignable to the early dynastic period, he found a fragment of green steatite vase with the figure of the humped bull done in the typical realistic Indian style so common in the treatment of the bull on the Indus Valley seals—which style we have already elaborately discussed. This find enabled him to postulate c. 3000 B.C.[6] Dr. Mackay has argued the date of roughly 2800 B.C. for a peculiar steatite vase fragment decorated in the same intricate and unusual fashion as a steatite double vase discovered at Susa in Susa II levels.[7] He was already inclined to this view on a comparative consideration of various archaeological finds in the Indus Valley, Mesopotamia and Elam,[8] when the steatite piece in question turned up from the lower levels of Mohenjo Daro.

These various archaeological finds point to roughly 3000 B.C. for the Indus culture. Can pottery sequences which we have studied throw any light on the problem? The monochrome black on red pottery with realistic designs found in the Indus Valley, which pottery provided the origin for Susa II ware, throws ample light on the question. Susa II corresponds to the early dynastic age in Mesopotamia, which began about 3000 B.C. Here is evidence from ceramic style to confirm the evidence from other remains.

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1 *e.g., ibid.*, No. 43, pp. 51 and 55, n. 3.

2 Hall-Woolley, *op. cit.*, p. 164.

3 Mallowan, *op. cit.*, Pl. III.

4 Gadd-Smith, *The New Links Between Indian and Babylonian Civilizations, The Illustrated London News*, October 4, 1924, pp. 614-616.

5 Frankfort, *The Indus Civilization and the Near East, Annual Bibliography of Indian Archaeology for the Year 1932*, pp. 1-12.

6 *Ibid., A New Site in Mesopotamia: Tell Agrab, The Illustrated London News*, September 12, 1936, pp. 432-434.

7 Mackay, *An Important Link Between Ancient India and Elam, Antiquity*, VI, pp. 356-357.

8 *Ibid., Further Links Between Ancient Sind, Sumer and Elsewhere, Antiquity*, V, pp. 459-473.

Can we go further back? The polychrome Jemdet Nasr pottery, which is earlier than Susa II contains realistic representations of birds.[1] Their bodies are rendered in the same way as the animals and birds in Susa II and the corresponding monochrome Indian pottery.[2] We refer to the cross-hatching that is peculiar to the Indian realistic type, as it is seen in the treatment of the ibex, the bull, the fish, the fowl, the pipal leaf and other designs. This part of Jemdet Nasr style has no parallel in the West. Its provenance has got to be sought in the East. Although in shape the Jemdet Nasr pottery may be different from the Indian, yet its naturalistic style it can owe to no other influence but the Indian. Hence Woolley saw in the Jemdet Nasr ware Eastern influence;[3] yet he would put it to Northern Elam. But as the style of Jemdet Nasr corresponds to Susa II closely, we ought to see in the former a very early phase of what came later on to be known as Susa II style, although Susa II epoch itself is later than the Jemdet Nasr era. That early phase is certainly the Indian realistic strain at the beginning of its penetration into the West. That the Indian style trickled into the West from very early times can be gathered from the findings of Woolley, who says that even from the Uruk period pottery of Susa II style was picked up, though not in large numbers, at Susa.[4] Here is definite proof that Indian influences infiltrated into Susa as early as the Uruk era. This would show that the realistic style of ceramic art and the black on red Indian ware on which that style is found are contemporaneous at least with the Uruk age.

It certainly would have required quite an appreciable amount of time for Indian artistic notions not only to develop and get established in India but, what is more, to traverse the whole length of Baluchistan and Persia to the latter's almost westernmost limits. Hence it may not be too hazardous to seek the beginnings of the monochrome ware in the Indus Valley in an age corresponding to at least the Al Ubaid period.

With this as the *point du depart* we can go yet further into antiquity with regard to the age of the Indus culture. The bichrome Amri ware with its purely geometric designs is earlier than the monochrome ware with realistic motifs. There is ample stratigraphical evidence to prove this. Wherever they have been discovered together the bichrome ware lay under the monochrome.[5] Although proper excavations have not yet been carried out to show the depth of the bichrome stratum, yet even the mere reconnaissances and meagre trial excavations point to quite a large extent of land over which the type of culture, the pottery stood for, flourished. From the Indus river to Tapa-i-Sultan Miri in eastern Persia bichrome ware has been recovered. We need not mention all the places. Sites like Amri,[6] Ghazi Shah,[7] Pandi Wahi,[8] Damb

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1 Woolley, *The Development of Sumerian Art*, Pl. 13a.

2 Mackay, *Further Excavations at Mohenjo Daro*, II, Pl. LXVIII, 24.

3 Woolley, *op. cit.*, p. 53.

4 Woolley, *op. cit.*, p. 52, and Pl. 13 b.

5 *Mem. A.S.I.*, No. 48, pp. 26, 81, 93. This is the case not only in the Indus Valley sites but also in the Baluchistan ones, *e.g.*, Kulli and Mehi (*ibid.*, p. 150).

6 *Mem. A. S. I.*, No. 48, pp. 26-28.

7 *Ibid.*, pp. 84-85.

8 *Ibid.*, p. 93.

Buthi,[1] Bandhni[2] and Chauro[3] in the Indus Valley, Kulli[4] and Mehi[5] in southern Baluchistan, Rana Ghundai[6] and Dabarkot[7] in northern Baluchistan, Chah Husaini,[8] Takkul,[9] Tump-i-Surkh-Qalat,[10] Hazar-Mardi,[11] and Tapa-i-Sultan-Miri[12] in eastern Persia may serve our purpose. It may well be that the period of culture connoted by the bichrome ware was quite popular and prevailed over a decent length of time. Anyway we have no means of verifying it in the present unsatisfactory state of excavations in the region marked by the kind of pottery under discussion. At any rate according to the method we have followed so far we can safely say that the bichrome ware should certainly have prevailed earlier than the Al Ubaid age. That means the bichrome ware in India would be contemporary with Susa I,[13] which is earlier than Al Ubaid, as is stratigraphically proved at Susa.

A diversion is called for here with regard to the nature of the bichrome ware—whether it is indigenous or foreign to the Indus Valley. Mr. Majumdar to whose credit falls the discovery of such ware at Amri, by which name the culture connoted by the ware goes, thinks that it is foreign to India, while the monochrome ware according to him is indigenous.[14] He has done this on the ground of the geometric designs on the pottery and its shapes—the straight-sided beaker, the hemispherical bowl and the squat pot—which are typical of the ware of Al Ubaid and Susa I. As the origin of such ware is located by scholars in the highlands of Persia, the Amri ware that seems completely indebted to the Highland ware except for an additional red colour is supposed to have been derived from the latter.

Without denying the plausibility of the grounds, on which Mr. Majumdar's conclusions are based, we may say that the attempt is rather premature : for the simple reason that Amri has not been excavated fully and we do not know what is in store for us below the bichrome ware stratum. As a matter of fact we do not know what we may stumble on in strata below those so far known to us in any site in the Indus Valley. Owing to lack of intensive excavations in any place and owing to the fact that not once has virgin soil been reached,[15] it is extremely hazardous to draw any definite conclusions from stratigraphical assumptions.

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1 *Ibid.*, p. 115.

2 *Ibid.*, p. 121.

3 *Ibid.*, p. 123.

4 *Mem. A.S.I.*, No. 43, p. 122.

5 *Ibid.*, pp. 156, 159.

6 *Ibid.*, No. 37, p. 52.

7 *Ibid.*, p. 57.

8 *Stein, op. cit.*, p. 130.

9 *Ibid.*, p. 137.

10 *Ibid.*, p. 140.

11 *Ibid.*, pp. 143, 144.

12 *Ibid.*, p. 179.

13 Amri ware may be earlier still, which opinion will be discussed in another paper.

14 *Mem. A.S.I.*, No. 48, pp. 151-153.

15 What a contrast to affairs in Mesopotamia, where virgin soil has been reached in at least a dozen places !

Hence we cannot as yet be sure of the foreign nature of the bichrome ware in India.[1]

Yet an answer will have to be found for the complete similarity in geometric designs and shapes between the Amri ware and that of Susa I. They were comtemporaneous, and we cannot say which influenced which. Anyway one thing is clear : Susa I shows such an advanced stage of chalcolithic culture with lots of copper implements[2] resting on virgin soil that it should necessarily have gone to Susa from outside. From where ? Although Susa I stage has been found in several sites in Persia and outside, *e.g.*, Anau, yet excavations will have to be thorough not only in Persia but also in Turkestan, Baluchistan and India before we can attempt a solution.

To sum up the chronological position, the least that we can say from the foregoing discussion is that the earliest stage of the Indus culture so far known was easily contemporaneous with Susa I and that the beginnings of civilization in the Indus Valley were very probably much earlier.

It is becoming increasingly evident that ancient cultures flourishing in adjacent centres were hardly self-contained. This has been proved by the comparative ceramic study we have made. If one thing is clear it is that India was certainly in the orbit of the Near-Eastern world. This is a problem that will lead to immense conclusions if only the archaeological work and the consequent stratigraphical science were abreast of the eagerness of students ready to utilize the available material.

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[1] There seems to be some reason for the suggestion of Prof. Gordon Childe (*op. cit.* p. 226) that Amri ware may well prove to be the direct ancestor of the Monochrome Indus ware.

[2] It is quite signficant that the Amri stage did not know any copper implements at all but only stone tools. Was the phase Neolithic ? How important to solve this problem !

INSURANCE FUNDS IN RELATION TO INDUSTRIAL FINANCE

By

V. V. KARKHANIS, M.A.

INTRODUCTORY

INSURANCE is an economic institution resting on the principle of mutuality with wide bearings on the progress of society, on the welfare of states and individual happiness. It provides a fund, the need for which arises from a chance occurrence, the probability of which can be estimated with a fair amount of definiteness. Fundamentally, it is a form of collective action and it teaches the individual the art of savings and investment by small, regular and suitable instalments. Severally, these insurance premia are very small contributions. Nevertheless, when brought and pooled together, they can function as national capital towards building up the economic structure of the country.

In the capital market of the country along with other credit and financing agencies, insurance companies with their long-term contractual obligations and large amount of funds play an important role. They are a great asset to our economic resources and have just passed the first phase of infancy. In future, with their increasing wealth they are destined to make a valuable contribution to the economic betterment of the country.

The important role of insurance companies will further be appreciated when it is seen that India is undergoing a rapid process of industrialisation. For ameliorating the poor economic conditions of the people such a rapid industrial growth on a wide scale is a vital need. To achieve this purpose and to increase the National Wealth of the country adequate long-term finance at a reasonable cost which industry can bear is equally important. Life assurance companies receiving a vast stream of money every year can perform yeoman services in this direction in India along with other credit and financing institutions. For that purpose a reorientation of their investment policy both from within and without is essential.

PROBLEM OF INVESTMENT OF INSURANCE FUNDS

The problem no doubt is beset with many difficulties. In the first place, the financial power of insurance companies should not be judged from the amounts of paid-up capital alone. This is a comparatively small amount in relation to the large and increasing life and other funds. These rapidly growing funds, apart from the specific objects of insurance belong entirely to the policy holders. They are an index of the financial strength and activity of insurance companies and can be utilised not merely in the interest of the small body of policyholders but in the wider interest of the country too.

Existing literature has not adequately dwelt upon this important aspect inasmuch as it does not present a close and intensive study of some of the representative Indian offices as is undertaken in England and the United States. Nor does it give and make a critical analysis of the premium income and assets in life and non-life business under different branches and their place in industrial finance. Further, in a study of this kind it is essential to take into account the broad features of investment policy followed by insurance offices in industrially advanced foreign countries. Above all, the problem of investment of insurance funds for the economic and industrial growth of the country is not an isolated proposition as in England where insurance offices enjoy since long the advantages of "freedom and publicity." In India the problem of investment of insurance funds has been mixed with legislative interference by the Insurance Act, 1938, which in addition is subject to the Government of India Act, 1935, and its commercial safeguards.

PRESENT CONTRIBUTION OF INSURANCE FUNDS TO INDUSTRIAL FINANCE

On a broad analysis[1] of the assets of all the Indian offices for the period 1928-38 under different types of investments as given in the Government Insurance Year Books, we have observed that about

55 per cent are in Indian Government, Foreign Government and States Securities.

10 per cent are in Miscellaneous sources consisting of Agents' balances, interest accrued and not payable, Outstanding Premiums, Cash and Bank Balances, Dead Stock, Stationery, etc.

10 per cent are in Policy Loans.

5 per cent are in shares of Indian companies.

12 per cent are in Port Trust, Improvement Trust Securities and Debentures.

8 per cent are in Mortgages and Real Property, etc.

100

The analysis of the total assets of Indian offices for the period 1928-38 will immediately reveal that on an average only five per cent of the assets of Indian offices are held in shares of Indian companies and this is surely a meagre contribution to industrial finance as compared with that in England.

COMPARISON BETWEEN BRITISH AND INDIAN OFFICES RE INDUSTRIAL FINANCE

In England insurance offices which are continually in command of large amounts enjoy the fullest freedom in determining their investment

[1] Investment of Total Assets of Indian Insurance Companies, Chapter V, Statement XXXI, Page 196 in "Investment of Insurance Funds in India with special reference to Industrial Finance."

policy internally inasmuch as it is not usual for the constitution of companies to impose any restrictions upon the investment policy. Even the Government has not placed any legislative restrictions externally, and it allows insurance companies to invest the funds as they think fit. They follow a deliberate policy of financing industries both for block or permanent and intermediate capital. Further, the practice adopted by banks, finance and insurance companies of building large reserves from current profits to meet emergencies has extended to commercial and industrial corporations in recent years. This system of building large reserves as a measure of safety and stability has also been responsible for the greater association of life offices in England with industry. In 1938 the amount invested by British Insurance companies in Debentures, Stocks and Shares of commercial and industrial undertakings stands at the colossal figure of £ 62 crores, *i.e.*, 34.46 per cent of the total assets £ 179 crores of the British insurance offices. In marked contrast with this, the amount invested in shares of Indian companies by Indian offices does not exceed the meagre amount Rs. 4.4 crores. The following statement of the assets of British and Indian companies will amply bear out this remark and would indicate that the British offices with their underlying policy of 'freedom and publicity, rather than State control' are in a far better position to make a substantial contribution to the industrial growth of the country.

Statement I

Assets held in Debentures and Stocks and Shares of British Insurance Companies and Indian Insurance Companies (000 omitted)

1928-38

British Companies			Indian Companies	
Year	Amount £	Percentage of Total Assets	Amount Rs.	Percentage of Total Assets
1928	31,68,57	26.85	79,13	3.39
1933	41,87,68	29.49	1,73,93	4.62
1934	43,67,25	29.82	2,22,85	5.29
1935	49,61,57	31.79	2,77,78	6.07
1936	54,22,10	33.16	3,40,59	6.74
1937	58,51,56	34.05	4,07,93	7.33
1938	61,69,39	34.46	4,38,08	7.06

Industrial Finance and Leadng Individual British and Indian Companies

The study of the contribution of insurance offices to industrial finance would remain incomplete without a comparison between the part played by both the British and Indian offices individually. For that purpose the following statements II and III of the contribution made by five leading British and Indian offices each to industrial finance will be found interesting.

STATEMENT II

Investments made by Five British Offices in Debentures, Preference and Ordinary Stocks

1928-37

Company	1928	1930	1932	1934	1936	1937
Prudential ..	31.5	35.6	32.0	32.1	32.8	34.5
Pearl	14.8	19.1	18.8	21.2	29.6	31.9
Refuge	34.6	32.6	36.0	32.5	32.3	32.5
Norwich Union ..	11.0	16.4	13.9	20.8	25.4	25.6
Sun Life	19.5	25.7	26.7	25.0	26.8	26.6

STATEMENT III

Investments made by Five Indian Offices in Shares of Indian Companies

1928-37

Company	1928	1930	1932	1934	1936	1937
Oriental ..	..	..	..	..	0.3	..
Empire	..	..	..	..	2.0	..
Hindusthan Co-operative ..	2.9	2.5	2.0	3.0	5.9	9.7
National ..	12.6	12.0	13.2	21.2	33.5	35.7
Bharat	23.7	25.3	34.5	37.9	41.1	37.6

The comparative study of the percentage of industrial equities to total assets of British and Indian insurance offices convinces us that British offices participate in industrial finance on a more extensive scale than the Indian offices in spite of their large funds.

GOVERNMENT SECURITIES AND INDUSTRIAL FINANCE

The meagre contribution of Indian insurance offices to industrial finance is primarily due to the excessive proportion of the low-yielding Indian Government Securities held by insurance companies. The internal conservative restrictions placed by the directorate of the foremost concern like the Oriental and the conservative policy of investment followed by the Empire, the Indian Life of Karachi, etc., are also responsible for this excessive proportion of investment of insurance companies in Indian Government Securities. In the balance sheets of all Indian companies for the financial year 1938, these three companies alone hold more than 45 per cent of the total assets and their conservative policy of investing an unusually large portion in purely Government Securities is a great impediment to the funds being directed to industrial finance. From the study of investments of representative Indian insurance offices and from the previous statements II and III, it can be easily observed that the leading concerns like the Oriental and the Empire which together held about 40 per cent of the total assets of all Indian companies invested

practically no amount of funds in shares of Indian companies. This conservative policy of the Oriental commanding large amounts of funds, can be accounted for by the fact that the internal constitution, unlike in England, precludes the Oriental from participating in industrial finance. Otherwise in the period of 1928-38 leading companies like the Asian, the Bharat, the Bombay Life, the Bombay Mutual, the Hindusthan Co-operative, the Industrial Prudential, the Jupiter, the Lakshmi, the National, the New India and the Western, of which we have made an intensive study have not only made a fairly large contribution to industrial finance but have shown increasing tendency towards the same. These leading companies not internally bound by any restrictive provisions in investing their funds in a particular type of investments are yet hard hit by the external measures embodied in the Insurance Legislation of 1938 as they have perforce to change their investments from shares in Indian companies to Government and Approved Securities. The participation of these companies in industrial finance is therefore bound to decrease in future and industries in India so urgently in need of capital of this type will be deprived of the same. If the tendency of increasing participation of these companies was allowed to continue and develop the capital resources of industries in India would have certainly increased. In view of the urgency of participation in industrial finance, the leading concerns like the Oriental have commenced to amend their Articles of Association but the scope allowed is still much limited. The capital resources of Indian industries will be still richer if other concerns like the Empire, the Indian Life, etc., abandon the conservative policy of locking a large portion of their funds in purely Government securities. Concerns like the Oriental and the Indian Life invest more than 70 per cent of their assets in purely Indian Government Securities, while the proportion of Government Securities in the total assets of all Indian companies, on an average for the period 1928-38 exceeds 55 per cent. With the expansion of insurance business in India, the total amount of funds available for investment is bound to increase. But in the absence of relaxation of control from without as well as from within the present overwhelming proportion of Government Securities unlike in other leading and civilised countries must remain the same.

Insurance Funds and Industrial Finance

In the balance sheet of a life assurance concern, on the liability side, the principal life fund, contingency reserves and investment fluctuation funds, etc., usually cover more than 85 per cent of the total liabilities. Out of these three funds the principal life fund amounts to more than 80 per cent and it is a liability to policy holders spread over a long period of 30 to 40 years and sometimes even more. This large proportion of the fund is not required immediately as cash and can, therefore, conveniently be locked up in long-term undertakings. Compared with the principal life fund, the contingency reserves or the investment fluctuation fund are a small amount.

Of the remaining 15 per cent of the liabilities about 6 or 7 per cent are the liabilities on account of claims, which are admitted or intimated but not paid, and some sundry creditors. About 5 per cent of the liabilities are due to the paid-up capital also and the balance is for other liabilities.

In order to safeguard and without endangering their own position for meeting liabilities owing to the claims by death as well as by maturity every year, it is essential for insurance offices to invest a reasonable proportion of the funds in easily realisable and convertible securities. To meet these liabilities of an immediate nature, it becomes incumbent upon insurance offices to maintain a reasonable proportion of liquid assets. The proportion of these liabilities of an immediate nature does not usually exceed 6 or 7 per cent and for this purpose it is advisable to hold about 10 per cent of the assets in Government and such other easily realisable types of investment.

Further, on the assets side, insurance offices are required to hold about 10 per cent in the Miscellaneous Sources of assets which include outstanding premiums, agents' balances, cash in hand and at the banks, dead stock, stationery, etc. Insurance offices are unable to use any discretion in these types of assets as they are mainly designed for running the administration and conducting the business. Most of these amounts which are compulsory lock up in this manner, are therefore unproductive, yielding no interest. The agents' balances are payable to them for the business they place. Cash in hand and at the banks is also not a large amount as in the case of banks which keep a much larger proportion to meet the day-to-day requirements. The small proportion of cash in hand or at the bank on current account consequently yields no large income.

Another major type of investment where insurance offices do not enjoy any choice are policy loans. About 10 per cent of the assets are held by insurance offices to meet the demand of policy holders for loans.

These three types of assets, *viz.*, Liabilities like claims requiring 10 per cent, Miscellaneous Sources, 10 per cent, and Policy Loans 10 per cent, in all absorb 30 per cent of the assets. No doubt out of the remaining 70 per cent of the assets, insurance offices may still hold about 10 per cent in readily available Government, Semi-Government or other forms to meet unforeseen contingencies like economic depression resulting in the reduction of new business and an increase in policy loans and surrenders or epidemics culminating in increased mortality or international conflagration. In all, therefore, out of the first 30 per cent and about 10 per cent of the assets for contingencies, Indian industries can hardly anticipate anything from this legitimate field of activity. But ample choice and discretion can be exercised both by the Government and insurance companies in the remaining 60 per cent of the assets with a view to help the industrial development of India.

Principal Consideration in Investment of Insurance Funds

This brief analysis of the balance sheet of an insurance office has already shown that insurance offices are required to place about 20 per cent of their assets in Government Securities for meeting the claims of an immediate nature and to face emergencies. But for meeting these demands it is not at all necessary to place rigid and conservative restrictions of investing such an overwhelmingly large amount of 55 per cent of the liabilities in Government and Approved Securities. These restrictions lead to block up and choke the urgent financial requirements of Indian Industries.

The principal considerations which must govern the investment policy of insurance funds are that in the first place Government Securities are not a suitable form for permanent and extensive investment although they are desirable for the purpose already referred to. In no leading and civilised country have insurance funds been recognised as merely satisfying the contractual obligations, but the same are invested with a view to further the economic welfare of the country too. A few years ago, owing to the scarcity of buildings and consequent high rentals in the United States, there was some agitation in favour of even statutory provision for compulsory investment of life assurance funds in real estate mortgages, particularly those on residential property. The point is not to suggest that statutory restrictions should be embodied in legislation which curtail the freedom of investment of insurance companies but to emphasize the role insurance funds are expected to play in the national economy. The underlying policy in the matter of investment of insurance funds should not, therefore, be to force the directorate of insurance offices to restrict their freedom of encouraging economic advancement.

Sound canons of investment of insurance funds further demand that the expansion of the benefits of insurance on the widest possible limits to the public should with equal consideration weigh with the directorate along with the security of capital and a highest practicable rate of interest. Insurance is an economic necessity for each and every individual and it is the legitimate function of insurance offices to cater benefits of insurance by bringing the same within the easy reach of all individuals.

The investment of insurance funds must lead to an increase in the *per capita* insurance which in turn will further accentuate the growth of capital resources. Insurance funds utilised as capital lead to further creation of capital and add substantially to the interest income which is one of the primary factors in the distribution of bonus to policy holders. This vital consideration should also govern the investment of insurance funds both with the Government as well as insurance companies as the *per capita* insurance in India is a miserably poor figure. The *per capita* insurance in India in 1931 was Rs. 5.73 while it stands at the figure of merely Rs. 9.73 in 1941.[1] The *per capita* insurance in India stands a poor comparison with that of the United States or other leading countries.[2] The United States of America with 7 per cent of the world population commands 70 per cent of the World insurance while India with 20 per cent of the World population carries insurance of almost negligible value.

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[1] Refer Appendices I and II.

[2] The *per capita* insurance in India and in some other countries is as follows :

Per Capita Insurance

United States of America	£	109
Canada	£	84
South Africa	£	60
England	£	53
New Zealand	£	52
India (1941)	Rs.	9.7

The whole spirit of insurance legislation and particularly in the matter of investments, therefore, demands that legislation should be in conformity with this objective of encouraging insurance offices to accomplish their aim rather than tighten their hands. The overwhelming percentage of the Government Securities under compulsion and yielding lower income than that on other industrial equities, mortgages, policy loans, etc., is a contravention of these principles and objectives. These rigid restrictions as embodied in the present Insurance Legislation of 1938 and probably unparalleled in the history of insurance in any country under a policy of State control rather than freedom and publicity have driven the insurance offices to place too much emphasis upon the element of insurance protection rather than investment. Unless, therefore, this excessive percentage of Government Securities is materially reduced with a view to satisfy the growing needs of industry and to increase interest income or investments, Indian insurance offices will not be in a position efficiently to perform their legitimate activity of financing industries.

New Plan of Investments for Indian Offices

With these principal considerations and in view of the urgent need for the rapid industrialisation of the country Indian insurance offices can make an immense contribution to industrial finance under a policy of complete "freedom and publicity" as exists in England or as that had existed before the present Insurance Legislation of 1938. If Indian offices enjoy those advantages of "freedom and publicity" which have been the guiding principle and ultimate goal adopted for Insurance Legislation in India, there will be a considerable reduction in the overwhelming percentage of Government Securities to the advantage of industries in India. It will then be enough to invest about 20 per cent instead of 55 per cent of the funds in Government Securities on the basis of the analysis of the balance sheet referred to before. Out of these 55 per cent of the liabilities about 30 per cent may then be diverted to industrial equities. The percentage of the shares of Indian companies which stands at present on an average of 5 per cent will consequently increase to 35 per cent. Similarly the remaining 5 per cent from the Government Securities may go to swell up the other types of investments like the Port Trust, Improvement Trust Securities and Debentures to the tune of 15 per cent instead of 12 per cent on an average at present. Mortgages and Real Estates which are suitable and remunerative forms of investments for life funds will also be benefited and show a rise to 10 per cent instead of 8 per cent. The broad analysis of the assets of Indian offices under a regime of "Freedom and Publicity" in the matter of investments will read as follows :—

	Investments of Indian Insurance Offices under Old Basis	Investments of Indian Insurance Offices under New Plan
Indian Government, Foreign Governments and States Securities, etc.	55 per cent	20 per cent
Miscellaneous Sources	10 "	10 "
Policy Loans	10 "	10 "
Shares in Indian Companies	5 "	35 "
Port Trust, Improvement Trust Securities and Debentures	12 "	15 "
Mortgages and Real Estates	8 "	10 "
	100	100

The above analysis evidently shows that under an active and modified plan of insurance funds, above 35 per cent of the assets will be held in industrial equities with a consequent reduction in Government Securities from 55 to 20 per cent. Increasing participation of insurance companies in industrial finance on this basis will enhance the net yield from about 2.49 per cent to 3.02 per cent[1] after deducting the heavy incidence of income tax, surcharge, super tax, etc.

According to this new basis, out of the total assets of Indian companies which amount to Rs. 62 crores in 1938 about 22 crores will be available for Indian industries. By an active and modified investment policy with the underlying principle of "freedom and publicity," Indian companies alone will finance Indian industries to the tune of Rs. 22 crores at present. This contribution of Indian Insurance Companies is bound to rise with the increase in the total assets in future. In the last ten years the total assets of Indian companies have increased by ten per cent every year and on the new basis of investment the increase will be on a still greater scale.

Industrial Finance and British and Foreign[2] Companies Operating in India

We have briefly surveyed the position of Indian offices in relation to industrial finance and made an approximate estimate which Indian offices can make at present. But apart from Indian offices there are also British and Foreign companies transacting a fairly large amount of business in India for a long time and the resources of Indian industries will enhance if their investments in India are properly directed to achieve the purpose of rapid industrialisation of the country on a wide scale. For that purpose it is necessary to take into account the position of both these types of companies.

Before the commencement of the present Insurance Legislation of 1938, which has enacted provisions to control the British and Foreign companies operating in India they enjoyed ample freedom. It was not obligatory upon them to make full disclosures in respect of their premium income, disbursements or life funds under their Indian business separately This was a legitimate grievance of Indian Insurance against these powerful British and Foreign rivals as the expenses incurred in the procuration of Indian business were substantially higher than those by Indian companies. The Government has now conceded some of the demands against these offices and have made it obligatory that the British and Foreign companies are to submit the results of their Indian business through separate revenue accounts, valuation statements, statutory deposits, etc. These provisions are, however, entirely inadequate from the point of industrial finance in India and the legislation in this respect also needs to be amended.

1 Refer Appendices III and IV.

2 By Foreign Companies it is meant concerns which are not established in India or the United Kingdom.

AMOUNTS OF ASSETS OF BRITISH AND FOREIGN COMPANIES IN INDIA

According to the Statistics for the year 1938, the total amounts of life assurance in force of the British and Foreign companies operating in India amounted to Rs. 43.35 crores and Rs. 50.96 crores respectively (Statements IV and V). In the same year the total amount of life assurance in force of Indian companies stands at the figure of Rs. 204 crores—a little over twice the amount Rs. 94.31 crores of the British and Foreign companies together. Adequate figures of the assets in support of their total amount of insurance in force in India are not available up to the year 1938. However, a minimum rough estimate can be arrived at taking into account the amount of insurance in force and its relation with the assets held by the simple method of proportion. For arriving at a more correct and conclusive figure of the estimate of assets necessary to support the total amount of insurance in force demands adequate data like the amounts of funds, the type and duration of policies, the investments made, etc., but this is not possible in the case of the British and Foreign companies in India. Adequate figures and statistical data of British and Foreign companies in respect of the total life assurance in force and new business completed in India at the end of the year 1939 under the Insurance Act, 1938, are not available. This information as well as the life assurance revenue accounts and valuation results in respect of Indian business for the year 1939 of non-Indian insurers are also not completely available. British and Foreign companies have been obliged to provide this information under the present Insurance Legislation. In 1938 to support insurance in force of Rs. 204 crores, Indian insurance offices held assets of all types to the tune of Rs. 62 crores. On the basis of this proportion and considering that the development of Indian business is recent, the minimum amount of reserves in India which must necessarily be held by the British companies may amount to Rs. 13 crores to support Rs. 43.35 crores of insurance in force, while the Foreign companies must have held Rs. 15 crores to support Rs. 50.96 crores of amount of insurance in force. The total assets of Foreign companies in India for the year 1938 amounted to Rs. 11.14 crores which even fall below the minimum Rs. 15 crores estimated above. The amount of assets held by the British companies in India is, however, more than the minimum Rs. 13 crores estimated.

Under the present Insurance Legislation, companies which are not incorporated in India or the United Kingdom are treated as Foreign companies. These Foreign companies are required to invest hundred per cent of their liabilities to the policy holders in India. And out of these hundred per cent of the funds they have to place 33⅓ per cent compulsorily in Government Securities and the balance of 66⅔ per cent again in Government and Approved Securities. Further, the assets of Foreign companies in respect of the obligations to the policy holders in India are required to be held in trust for the discharge of claims and are vested in Trustees resident in British India and approved by the Central Government. No doubt these are healthy provisions from the point of the security of the policy holders as Foreign companies used to invest much smaller amounts in India than the minimum required every year. But financial resources of Indian industries do not stand to gain

STATEMENT IV

Particulars relating to New Life Assurance Business in India of the British and Foreign Companies operating in India

In Thousands of Rupees

	1929		1930		1931		1932		1933	
	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount
British Companies	14,279	4,74,11	12,116	4,05,58	9,035	3,30,60	8,951	3,35,42	10,028	3,53,22
Foreign Companies	25,319	7,48,03	27,307	7,70,24	19,194	6,28,88	16,969	5,39,62	18,435	5,36,58

	1934		1935		1936		1937		1938	
	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount
British Companies	11,746	4,00,41	12,623	4,31,59	13,929	4,57,06	13,832	4,64,20	10,390	4,07,44
Foreign Companies ..	19,809	6,13,60	21,374	7,30,61	20,206	6,17,59	17,217	5,01,33	15,562	4,34,51

STATEMENT V

Particulars relating to Total Life Assurance Business (inclusive of Bonuses) in force in India of the British and Foreign Companies operating in India

In Thousands of Rupees

	1929		1930		1931		1932		1933	
	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount
British Companies	77,895	32,42,31	80,721	33,26,81	82,041	34,00,74	83,010	34,67,95	86,405	35,65,46
Foreign Companies ..	1,05,745	31,65,83	1,21,982	36,49,67	1,29,728	39,58,64	1,36,757	42,01,81	1,44,598	43,56,69

	1934		1935		1936		1937		1938	
	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount	No. of Policies	Amount
British Companies	91,511	37,01,111	97,204	38,97,15	1,03,502	42,13,31	1,05,379	42,56,56	1,08,069	43,35,06
Foreign Companies	1,52,972	46,22,43	1,61,955	49,80,42	1,68,736	50,94,43	1,66,931	50,03,87	1,68,074	50,95,96

that the British companies would utilise the remaining 45 per cent of the funds for the development of Indian industries by investing them in the same. On the other hand by allowing them freedom of investment, it is likely that they may invest the same in their own industries in India detrimental to the interests of Indian nationals. With the increasing capital resources out of Indian business under their control, they may create vested interests of their own, distribute the profits among themselves and facilitate employment of their own nationals in India in key positions. The flight of capital out of Indian borders is a permanent loss to the economic resources of the country and this is a possibility which cannot be ruled out. Another disadvantage of the freedom of investment of insurance funds even in its limited field in India is that it may lead to gain political influence for the British companies which may influence adversely upon the progress of the country. Sometimes it is argued that so long as insurance companies either British or Foreign are discharging their obligations to the policy holders in India properly a large amount of money by way of claims and remuneration to some of the staff, etc., is retained in the country. They should not, therefore, be subject to restrictions which would curtail their freedom of investments. No doubt there is some truth in this argument but the fact remains that a large amount of profits goes out of the country, important and key posts are held by foreigners and, above all, investments are made in the industries of their own creation. Indian industries which are urgently in need of financial assistance for their own growth and expansion are deprived of their financial resources and every possible measure must be considered with that objective. British interests in insurance as well as in other spheres have always vindicated a policy of 'fair field and no favour' and the present favourable treatment in preference to Foreign offices and on the same level with Indian offices is the result of this policy. At present the volume of life assurance business completed by Indian companies has been a growing one but it does not mean that the stake of the British and Foreign companies in life assurance is a small one in India. In the year 1938 the amount of life assurance in force with the British and Foreign companies exceeded Rs. 43 crores and Rs. 50 crores respectively as against Rs. 204 crores of Indian companies. In brief, by treating the British companies on an equal footing with Indian concerns, Indian industries are not only deprived of substantial and increasing amounts from being utilised for themselves but British companies are allowed to nurse and encourage their own industries on Indian soil and thus increase their political control and influence. In the formulation of the present Insurance Legislation these considerations had little weight.

British Insurance Companies and Canadian Legislation

For giving impetus to the indigenous industry the system of requiring foreign companies to keep within the country assets sufficient to meet liabilities exists in America and in some of the countries on the Continent. In the case of British and Foreign companies operating in Canada the legislation makes a clear distinction from the Home companies. Every British eompany transacting business of life assurance in Canada has to maintain assets of an amount at least equal to its liabilities to policy holders in Canada. The introduction of provisions in respect of Foreign offices for the retention of assets in India sufficient to meet the liabilities

to the policy holders in India is not therefore a new innovation. In Canada it is the principle that Canadian companies are required to maintain funds in Canada equal to the liabilities to the policy holders in Canada. Canadian companies are not required to maintain these funds in trust and are given ample freedom of investment. British companies are required to keep funds for matured claims and the reserves for outstanding claims also in Canada. Further, British companies are required to maintain these assets in trust for the benefit of the policy holders. In the case of failure or liquidation of the Company, war and hostilities between two nations, fluctuations in exchange, depletion of currencies or ban against sending out moneys, etc., the indigenous policy holders are likely to suffer. In order to avoid these dangers it is the practice to create trusts for the proper discharge of claims of the policy holders.

New Basis of Investment Policy for British Companies in India

The favourable position which British companies enjoy in India has deprived Indian industries of a large amount of capital resources. No doubt the amount of total assets of British companies in India is larger than the minimum Rs. 13 crores estimated before. But substantial amounts over this minimum are not out of Indian business but are investments made out of the funds derived from world organisation of British companies. They cannot thus be claimed for the financing of Indian industries. British companies can deal with the same in the way they choose. But in order to ensure better security to the policy holder in India as well as to enrich the financial resources of Indian industries, it is necessary that the British companies are not "deemed" as Indian and are treated as Foreign in India. They should not receive discriminatory treatment in preference to Indian concerns nor should they be treated as Indian as under the present legislation. They should further be obliged to retain their funds equivalent to their total liabilities to the policy holders in India instead of 55 per cent. These funds as in Canada should be vested in the trustees resident in British India and approved by the Central Government to guard the interest of the policy holders in case the Company goes into liquidation or meets with a failure, etc. Further, the British companies should be obliged to invest their funds on the same broad basis already proposed for the Foreign companies.

On this basis out of the total assets amounting to a minimum of Rs. 13 crores, 30 per cent of the same, *i.e.*, about Rs. 4 crores may be placed by the British companies at the disposal of Indian industries and their development. In all, therefore, the British and Foreign companies together can place at the disposal of Indian industries an amount of Rs. 9 crores (Rs. 5 crores Foreign companies and Rs. 4 crores British companies.)

Post Office Insurance Fund and Industrial Finance

The Postal Insurance Fund conducted at present by the Government since the year 1883 has not proved to be very popular except being a rival to the indigenous enterprise. The amount insured (minimum

Rs. 100 and maximum Rs. 20,000) competes both with the Provident Insurance Society and the office initiated by private enterprise. Endowment assurance matures not earlier than age 45 nor are disability benefits offered. Further, the most useful privilege of policy loans enjoyed by every policy holder insuring with private concerns is not offered by this Fund. Policy loans have proved to be a very important form of credit not only in normal times but even in adverse times like trade slump, economic depression, etc., when banks are unwilling to advance credit. Sub-standard lives which receive the necessary insurance cover under different plans in commercial insurance companies are not accepted by the Postal Insurance Fund. It is not compulsory for the Postal or Government employees to insure with this Fund and the premiums are not necessarily cheaper as the bonuses of private commercial companies are much higher. Further, a comparison between the new business effected by the Indian companies and the Postal Insurance Fund immediately convinces that there is a continuous increase in the popularity of Indian companies, while the popularity of the Postal Fund has been waning among those for whom it is meant. The following few figures from this point of view will be interesting :—

STATEMENT VI

Number of Policies and Business Effected by Indian Companies and the Postal Insurance Fund in the Period 1929—38

In Lakhs of Rupees

Year	Indian Companies: Number of Policies	Indian Companies: New Business effected in India	Postal Insurance Fund: Number of Policies	Postal Insurance Fund: New Business
		Rs.		Rs.
1929	1,03,079	16,39	7,582	1,43
1930	1,05,686	15,68	8,894	1,50
1931	96,909	17,09	9,710	1,50
1932	1,13,213	18,95	6,484	98
1933	1,54,920	24,09	4,215	81
1934	1,83,063	27,97	5,292	1,06
1935	2,04,799	31,57	4,835	1,04
1936	2,39,272	35,98	5,489	1,19
1937	2,62,997	39,05	5,438	1,16
1938	2,98,478	43,30	4,294	89

The investments of this fund are not published and it is presumed that practically the whole of the amount of life fund is in Government borrowings. Under the Post Office Insurance Fund the amount of life fund at the end of the year 1939 amounted to Rs. 8.55 crores.

In England the system of life assurance through the medium of the Post Office was inaugurated earlier than in India in 1864 by an Act of Parliament. The unsound financial position of some of the friendly societies and assurance companies then was mainly responsible for providing the working classes with a means of assurance based upon unimpeachable security. But with the marvellous growth of private commercial life assurance and especially industrial life assurance, it was difficult for the Postal Insurance Scheme to compete with them. In 1928 the Select Committee on Estimates stated that the Postal Insurance Schemes were a mere distraction of Post Office energies which might be better employed. They further expressed the view that the Fund should be discontinued in consideration of the immense growth and strength of commercial insurance companies, the necessary restrictions of investment of Post Office insurance funds in British Government Securities alone and the extreme difficulty of competing seriously for new business. The popularity of this Fund after about half a century's progress can be judged from the amount of insurance in force which was merely £500,000 on 31st December 1928. In the absence of proper response, the system was discontinued.

The Post Office Insurance Fund in India bears some resemblance to the Postal Insurance Schemes in England both in its origin and working. Earlier than in 1928 in England the Departmental Committee of 1907 has not approved of the policy of investing the entire Post Office Insurance Funds in Government Securities. The Committee recommended that a substantial portion of the Fund should be invested in the most remunerative Parliamentary Securities.[1] In India, to encourage the private enterprise as well as to utilise the present life funds under Postal Schemes in the most remunerative and productive channels, it would be desirable to discontinue the Post Office Insurance Fund. Such a measure would avoid the unnecessary competition between the Commercial Companies and the Government Schemes. Indian life assurance is indeed in need of protection from the encroachment by the Post Office Insurance Fund as it has been exempted from the operation of the Insurance Act, 1938. Further, Provincial Governments are also allowed choice to initiate their own insurance schemes. The Postal Insurance Fund is itself a misnomer. It has already assumed large dimensions as it is made open to all Civil Government employees. In the absence of nationalisation of all insurance by the Government there is no advantage in the continuation of this State activity as a rival to the private enterprise in the interest of the public. Further, a step of this nature will not only strengthen the financial resources of Indian offices which would in the future complete larger amounts of business with better services and advantages to the policy holders but they will be placed in a more advantageous position to utilise the funds for the economic and industrial advancement of the country. It would be desirable, therefore, that the Post Office Insurance Fund is discontinued, for, it has outlived its utility. And on the same basis adopted for Indian offices, out of the total Post Office Insurance Fund amounting to Rs. 8.55 crores in 1939, about Rs. 2.50 crores, *i.e.*, 30 per cent can be diverted to more productive industrial finance.

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[1] *Dictionary of Life Assurance*, by G.W. Richmond, F. I. A., and F. H. Sheriff, F.I.A., page 402.

A brief study of the various credit and financing agencies and the problems of industrial finance in India would reveal that along with the Postal Insurance Fund, insurance companies—Indian, British and Foreign—can play a useful role as suppliers of intermediate and long-term finance in the capital structure of the country. At present in comparison with the contribution of British and American offices, the contribution of Indian offices to industrial finance in India is meagre. But under a policy of "freedom and publicity" for Indian offices as exists in England and a modified basis for the British and Foreign companies operating in India, financial resources of Indian industries will receive an encouraging assistance. According to the statistics up to the year 1938, for the growth and advancement of Indian industries the amount of insurance funds that would be available at present from various insurance institutions amounts to Rs. 33.50 crores. The contribution to industrial finance from respective insurance institutions in India will be as follows :—

STATEMENT VII

Contribution of Insurance Funds to Industrial Finance

Indian Companies	22	crores
British Companies operating in India	4	,,
Foreign Companies ,, ,, ...	5	,,
Postal Insurance Fund	2.5	,,
	Rs. 33.5	

To ensure these amounts and for maintaining a continuous flow from the increasing assets every year, it will not be merely enough to allow ample freedom for Indian offices by relaxing the present rigid control from without, but it will be necessary to effect internal changes in the constitution of some of the leading offices with large amounts of funds. It will also be necessary to modify the Government of India Act, 1935, and its Section 113 regarding the commercial safeguards for British companies as the present Insurance Legislation in India is subject to the Government of India Act. Thus the policy of freedom of investments inspired not merely by the consideration of safety of principal and a reasonable yield but by objectives of an adequate increase in the *per capita* insurance and industrial advancement will maintain a continuously increasing stream of capital canalysing into insurance companies. British companies should for this purpose be treated as Foreign companies and British and Foreign companies should invest their funds in India on the basis proposed above. Under such a plan for Indian, British and Foreign companies engaged in insurance business in India, more and more funds will be invested in Indian industries which would surely enhance the National Wealth.

APPENDIX I

Estimate of Per Capita Insurance in India for the year 1931

	Number of Policies effected in India	Amount of Life Insurance in force in India (including Bonuses)
		In Lakhs of Rs.
Indian Companies	5,02,144	93,96
British Companies operating in India	82,041	34,01
Foreign Companies operating in India	1,29,728	39,59
Post Office Insurance Fund ..	79,058	15,33
Baroda	*Nil.*	*Nil*
Mysore Official Branch ..	27,119	2,26
Public Branch ..	11,123	1,23
Travancore	*Nil*	*Nil*
Nizam State	*Nil*	*Nil*
	8,31,213	1,86,38

Population of British India in 1931	27,15 lakhs
Population of States in India in 1931	8,13 ,,
Total ..	35,28 lakhs
Per Capita Insurance in India	1,86,38 / 35,28 = Rs. 5.73

APPENDIX II

Estimate of Per Capita Insurance in India for the year 1941

	Number of Policies effected in India	Amount of Life Insurance in force in India (inclusive of Bonuses)
		In Lakhs of Rs.
Indian Companies*	15,18,469	2,49,54
British Companies operating in India**	1,13,450	4,500
Foreign Companies operating in India**	1,70,360	5,200
Post Office Insurance Fund† ..	1,03,616	22,15
Baroda	3,315	16
Mysore Official Branch ..	30,359	2,59
Public Branch ..	45,274	4,15
Travancore	7,488	64
Nizam State	34,098	2,14
	20,26,429	3,78,37
Per Capita Insurance in India ..	.. 3,78,37 / 38,88 = Rs. 9.73	

*22½ per cent increase on the figure of 1938 @ 10 per cent—every year.

**Estimated at the rate of an increase of about Rs. 1 Crore—each year on the figures of 1938.

†3 per cent increase every year on the figures of 1939.

APPENDIX III

Estimate of the Net Yield Earned on Investments Subject to the Insurance Act, 1938, and its Restrictions

Type of Investment	Amount Invested	Gross Rate of Interest Assumed	Income Rs.
Policy Loans	10	6 %	.60
Miscellaneous Sources	10	*Nil*	*Nil*
Government, State and other Securities	55	3½%	1.93
Port Trust, Improvement Trust Securities and Debentures	12	4 %	.48
Mortgage and Land Estates, etc. ..	8	5 %	.40
Shares of Indian Companies	5	6 %	.30
	100		3.71

Less Income Tax, Super Tax, Surcharge, etc., at 63 pies per Re. 1.22

2.49%

APPENDIX IV

Estimate of the Net Yield that may be Earned on Investments under "Freedom and Publicity" and with a view to Finance Industries in India

Type of Investment	Amount Invested Rs.	Gross Rate of Interest Assumed	Income Rs.
Policy Loans	10	6½%	.60
Miscellaneous Sources	10	..	..
Government, State and other Securities	20	3½%	.70
Port Trust. Improvement Trust Securities and Debentures	15	4 %	.60
Mortgages and Land Estates, etc. ..	10	5 %	.50
Shares of Indian Companies	35	6 %	2.10
	100		4.50

Less Income Tax, Super Tax, Surcharge, etc., at 63 pies per Re. 1.48

3.02%

KARACHI MUNICIPAL SWEEPERS

An Enquiry* into their Conditions of Life and Work

By

S. T. Merani,

Labour Office, Karachi

Preface

I DO not claim any absolute accuracy for the data collected by me which I have tried to analyse in the following pages. The figures which form the basis of the whole Enquiry are those that were given to me by the Sweepers themselves ; these figures were, however, carefully scrutinized and wherever possible checked by asking some corroborative questions.

My object in conducting this Enquiry will have been achieved if something is done, as a result of it, to better the lot of these people, who are so very essential to society and yet whose proper place in it remains unrecognised.

Scope

The present Enquiry has been conducted only amongst those families of Sweepers who are in the employment of the Karachi Municipality. It was not possible to collect information about Sweepers who carry on their trade privately because they are scattered throughout the city, without having their residence in any fixed locality—living in hotels, hospitals, private bungalows, etc., which makes sampling very difficult. Moreover, the Sweepers who live in private bungalows, in addition to free quarters, receive old clothing free and their expenditure on food is also negligible, as they receive plenty of leavings of food. It was therefore not desirable, even were it possible, to mix up the two classes of Sweepers and allow the circumstances of one to affect the results of an Enquiry among the other.

The Enquiry has been conducted by "interview method" and so budgets have been personally collected from different families in different Quarters. The form of Enquiry (Appendix A) will show the heads under which information was obtained.

The sole object in conducting the Enquiry has been to collect some statistical data regarding the conditions of life and work of this small but very important community. As it was not intended to arrive at "weights" for preparing any Cost of Living Index Numbers, no detailed information was registered under the different sub-heads in the expendi-

* The Enquiry was conducted in 1938.

Mr. Lusk's Co-efficients are reproduced below for clearly understanding the family composition which has been expressed in their terms :—

Lusk's Co-efficients

Age and Sex	Co-efficients
Adult man	1.00
Adult woman	0.83
Boys between 14—20 years..	1.00
Girls „ „ „	0.83
Boys and Girls between 10—14 years	0.83
„ „ „ „ 6—10 „	0.70
Children between 4—6 years	0.50
Children below 4 years	

Some critics argue that these co-efficients are not representative of Indian conditions and therefore must not be applied here. But in the absence of any others, they are the most suitable ones. Moreover, a scale of co-efficients, though it may represent Western conditions, can with certain amount of success be applied to India also, as the co-efficients are mainly in the form of a relative scale. The figure 1.00 as indicating an Indian adult male may differ in actual value from a similar figure indicating a European adult male, but it will be found that women and children can bear comparison under a co-efficient scale to adult males of the same group or country to which they belong whether in India or outside.

The Bombay Labour Office has conducted two Family Budget Enquiries among the Working Classes in Bombay City—one in the year 1921-22 and the other in 1932-33. The former disclosed that an average family consisted of 4.2 persons while the latter showed that the economic responsibility of the head of an average family pertains to 4.35 persons. An average family among Sweepers, as has been mentioned above, consists of 4.48 persons, *i.e.*, there are .13 persons more in an average family amongst the Sweepers at Karachi than in a working class family at Bombay. The existence of a larger family among the Sweepers can partly be explained. A Sweeper hates to remain single and if his wife dies he marries again and again till he reaches an age when he can marry no longer. He remains in matrimony for a longer period than other classes of workers and therefore becomes the father of more and more children. Their women also spend almost the entire period between puberty and menopause in wedlock, as they marry very early, and therefore have a longer period during which they exercise their power of reproduction.

A classification of families showing their different sizes in different income groups along with their percentage figures will be very interesting and is therefore given below :—

Income Groups	Average Size of the Family in the Group	Families in the Group by Percentage
Below Rs. 30	3.48	40%
Rs. 30 and below Rs. 40	4.61	12%
Rs. 40 and below Rs. 50	5.09	34%
Rs. 50 and below Rs. 60	5.58	4%
Rs. 60 and below Rs. 70	4.71	4%
Rs. 70 and below Rs. 80	6.69	2%
Rs. 80 and below Rs. 90	6.41	4%
All Incomes	4.48	100%

40 per cent of the families included in the Enquiry fall within the income group "Below Rs. 30," whereas only 2 per cent are in the income group "Rs. 70 and below Rs. 80," 34 per cent in the group "Rs. 40 and below Rs. 50" and 12 per cent in the group "Rs. 30 and below Rs. 40."

The Family Budget Enquiry of 1932-33 conducted amongst the working classes in Bombay showed that over 62 per cent of the families came within the income group "Rs. 30 to Rs. 60," whereas here only 50 per cent of the families fall within the same group. This shows that there is a smaller number of families here who are in that income group, where alone a worker finds it possible to maintain a tolerable standard of living.

Another interesting fact which the above table brings out in relief is that the largest average family cosisting of 6.69 is in the income group "Rs. 70 and below Rs. 80" closely followed by an average family consisting of 6.41 persons in the group "Rs. 80 and below Rs. 90." The smallest average family is in the group "Below Rs. 30" consisting of 3.48 persons. This difference in the size of the family in different income groups is largely due to greater or smaller number of earning members in a family that falls in any particular group, as it is the number of adult males and females in a family that are responsible for a higher or lower income.

Literacy

Amongst the men only 44 per cent were educated, the women were illiterate except in 4 per cent cases, and only in 30 per cent cases were children sent to school. This is a very regrettable state of affairs, as there is absence of any satisfactory male or female education.

The Sweepers do not favour female education. When a girl is young, she is not sent to school ; when she grows up she is married and begins her career as an instrument of procreation. Education has no place in her daily routine, as she is busy the whole day either working at home or outside. Woman is the bulwark of society, and unless she is educated, she cannot look after her children properly; their health, education and growth suffer on account of her ignorance.

As far as children are concerned, it is a wonder that in a place where primary education is said to be compulsory, the children of the employees

of a public body like the Municipal Corporation are sent to school only in 30 per cent cases. Whenever a father was asked to explain why his children did not go to school, the reply was always evasive. In one case a father (of many boys and girls) flared up and answered with an intense emotion: "Who is there," he said, "to impart education—proper education—to the children of Sweepers, who are still regarded as untouchables? Are we not shunned wherever we go? Do not your women and men, if ever they happen to touch us,—we human beings,—go and wash themselves, as if we were filth? When you yourself know all this, how can you ask such a question? Only when we have Sweepers as teachers or teachers who treat our children as they treat the rest of the pupils in the class, will we send them to school!"

Grades of Pay

A Sweeper in the old grade works in the pay scale of Rs. 20-1/2-22 which has subsequently been revised and for the new entrants reduced to Rs. 19-1/2-21. For the drivers of refuse carts the old grade is Rs. 21-1-24 but for the new entrants this too has been reduced to Rs. 20-1/2-22. The Muccadams, who are promoted from Sweepers after a period of meritorious service, were formerly engaged on Rs. 22-1-25 but this grade has also been reduced to Rs. 21-1-25 for the new entrants. It will thus be seen that the pay scales of all classes of Sweepers have been reduced. Reduction is made where it is least desired!

Payment of Wages

The Sweepers get their pay by the 10th of each month, because the Corporation Staff takes long to prepare their pay bills, etc. During the month a Sweeper sometimes works at more than one place and therefore his pay is to be drawn from more than one budget head. It is, therefore, that the pay bill can be prepared only after the month is over and not in advance as is done in the case of other employees. This is an inconvenience which is keenly felt and the Municipality ought to make proper arrangements for the payment to be made on the 1st of each month, at least to those Sweepers who have worked at the same place for the entire month.

Income

The average income of a family comes to Rs. 37-6-7. 56.30 per cent of it is earned by men, 20.77 per cent by women, 2.03 per cent by children, while the dependants contribute nearly 16.36 per cent—the remaining 4.54 per cent coming from "Family's other sources of Income besides the regular pay received by the various members." Only one family had the maximum income of about Rs. 90/-, whereas there were several families who had the minimum income of Rs. 19/-.

A classification of budgets by income groups produced below shows that 50 per cent of the families fall within the income group "Rs. 30 to Rs. 60." The maximum number of families, *viz.*, 40 per cent of the total number come within the income group "Below Rs. 30" closely followed by 34 per cent falling within the group "Rs. 40 and below Rs. 50." In the higher groups the percentage of families is very small, 4 per cent being in groups "Rs. 50 and below Rs. 60," "Rs. 60 and below

Rs. 70" and "Rs. 80 and below Rs. 90" respectively, and only 2 per cent in the group "Rs. 70 and below Rs. 80." This shows that there are very few families whose income is large enough to admit any expenditure on luxuries besides the bare necessaries of life.

Classification of Budgets by Income Groups

Income Groups	Percentage to Total
Below Rs. 30	40%
Rs. 30 and below Rs. 40	12%
Rs. 40 and below Rs. 50	34%
Rs. 50 and below Rs. 60	4%
Rs. 60 and below Rs. 70	4%
Rs. 70 and below Rs. 80	2%
Rs. 80 and below Rs. 90	4%

EXPENDITURE

Against an average family income of Rs. 37-6-7, there is an expenditure of Rs. 33-7-7, the average expenditure per person being Rs. 7-7-8.

A matter of considerable importance from the point of view of the standard of living of a family is the distribution of its expenditure on the various articles and services included in the budget. That is to say, it is important from the point of view of material well-being that the expenditure on various groups of articles and services should be fairly well-proportioned and that the family should not be called upon to spend the whole of its income on mere necessaries required for bare subsistence. An analysis of expenditure on various groups therefore becomes a matter of vital interest and is set out below :—

Groups	Percentage Expenditure	Average Expenditure per Family	Average Expenditure per Head
		Rs.	Rs.
Food	47.80	16 0 0	3.57
Clothing, etc.	14.31	4 12 8	1.07
Lighting and Fuel	8.32	2 12 7	.62
Miscellaneous	29.57	9 14 4	2.21
All Groups	100.00	33 7 7	7.47

Before proceeding to discuss the percentage expenditure on various groups in detail, it will not be out of place to compare it with group expenditure figures at other places in India and outside. Though it will not be excactly accurate to compare the group expenditure figures obtained as result of Enquiries conducted in other places, without detailed particulars with regard to the classification of expenditure adopted in those Enquires, being available, it will still be very instructive to study the manner in which workers at different places distribute their expenditure. While making a comparison it should also be remembered that the figures for Karachi relate not to the entire working class population but to a small community of non-industrial workers, like the Sweepers.

Comparison of Group Percentage Expenditure Ascertained During the Present Enquiry with that of Similar Enquiries Conducted in Other Countries

Country	Date of Enquiry	Percentage Expenditure on						Total
		Food	Heating & Lighting	Clothing	Bedding & Household Necessaries	Housing	Miscellaneous	
Finland	1920-21	62.5	4.9	15.6	..	6.4	10.6	100
Irish Free State	1922	57.1	7.0	17.5	..	5.4	13.0	100
Netherlands	1923	43.4	6.3	9.3	..	17.5	23.5	100
Sweden	1923	45.3	4.4	13.6	..	13.6	23.1	100
Switzerland (Basle)	1923	49.5	6.9	10.8	..	16.3	16.3	100
Estonia	1925	57.9	..	18.2	..	14.3	9.6	100
China	1926-27	72.2	11.3	6.8	..	8.0	1.7	100
Japan	1926-27	39.8	4.5	13.0	..	15.8	26.9	100
Czechoslovakia	1927-28	55.6	4.9	13.0	..	7.0	19.5	100
Germany	1927-28	46.3	3.7	13.0	..	14.2	22.8	100
Norway	1927-28	44.3	4.8	13.6	..	14.4	22.9	100
Poland	1927-29	63.2	4.6	12.9	..	6.6	12.7	100
Russia	1928	49.2	5.1	20.2	..	10.4	15.1	100
United States	1929	33.4	6.0	12.5	..	27.8	20.3	100
India (Bombay)	1921-22	56.8	7.4	9.6	..	7.7	18.5	100
,, ,,	1932-33	46.6	7.1	7.8	0.1	12.8	25.6	100
India (Karachi Municipal Sweepers)	1938	47.8	8.3	14.3	..	..	29.6	100

Expenditure on Food. It includes family expenditure on Cereals, Pulses, Sugar, Tea, Fish, Mutton, Vegetables, Milk, Ghee, Salt, Spices, Sweet Oil, etc. 47.80 per cent of the total expenditure is on food, the average per family being Rs. 19-0-0, *i.e.*, Rs. 3.57 per person. It would still be higher if the Sweepers' wives and children did not sometimes get remnants of food from private homes. A classification of average expenditure on food per family by income groups, which is produced below, shows that the maximum expenditure on food is in the group "Rs. 60 and below Rs. 70" and the minimum in the group "Below Rs. 30."

Income Groups	Average Expenditure on Food per Family
	Rs.
Below Rs. 30	10 5 2
Rs. 30 and below Rs. 40	14 8 0
Rs. 40 and below Rs. 50	17 9 5
Rs. 50 and below Rs. 60	27 8 0
Rs. 60 and below Rs. 70	32 8 0
Rs. 70 and below Rs. 80	20 0 0
Rs. 80 and below Rs. 90	27 8 0
All Incomes	16 0 0

Expenditure on Clothing, etc. This group includes expenditure on all kinds of clothing, shoes, etc., *e.g.*, Dhoti, Pairan, Coat, Pants, Sari, Choli, Coati, Rava, Sulvar, Turban. 14.31 per cent of the total expenditure is on clothing, *i.e.*, Rs. 4-12-8 per family or Rs. 1.07 per head. The expenditure in this group also would be higher but for the free uniforms supplied by the Municipality.

Lighting and Fuel, etc. In this group expenditure on charcoal, firewood, kerosine oil, matches, etc., is included. It comes to 8.32 per cent of the total expenditure, *i.e.*, Rs. 2-12-7 per family or Rs. 0.62 per head.

Miscellaneous Expenditure. This group includes items of expenditure on both luxury and non-luxury goods and services not included in any other group, *e.g.*, Barber, Dhobi, Soap, Medicines, Pan Sopari, Tobacco, Bidies, Cigarettes, Liquor, Cinema, Postage, Tramfare, Toilet requisites, Pocket expenses, Ready-made tea, Payment to dependants, etc. The debt charges are not included in this group or any other group. 29.57 per cent of the total expenditure is on items included in this group. Each family spends Rs. 9-14-4 on this group or Rs. 2.21 is the expenditure per head.

Being made up of several items, expenditure in this group was tabulated under four sub-heads, *viz.*, "Alcohol," "Cinema, etc.," "Cigarettes, tobacco, etc." and "Other items." 12.53 per cent of the expenditure on the Miscellaneous group is on "Alcohol." It was observed that the Sweepers were very unwilling to divulge their secret about drinking and the amount wasted on it. In spite of being addicted to it, at least on the pay day, they denied ever going near the liquor shop. This was perhaps because they were aware of the social stigma attached to liquor and therefore felt it below their human diginity to own this demoralising habit. In this consciousness alone that "Drink is evil" and that the habit of drinking is demoralising for human dignity, lies the best hope that one day this evil will be completely eradicated if, the Congress continues its fight with the same zeal as it is doing now. "Cinema," etc. accounted for 2.48 per cent of the expenditure, while 27.89 per cent was spent on "Cigarettes, tobacco, etc."—"Other items" included in this group taking up a large share, *viz.*, 57.10 per cent of the total expenditure under this group. The percentage expenditure on the Miscellaneous group is set out in the table below :—

Items	Percentage Expenditure
Alcohol, etc.	12.53%
Cinema, etc.	2.48%
Cigarettes, tobacco, etc.	27.89%
Other Items	57.10%

SURPLUS OR DEFICIT

In the case of the 70 per cent of the families covered by the Enquiry, there was some kind of saving. The maximum amount saved was Rs. 34-0-0 by a family whose income was about Rs. 90-0-0 per month with a family composition of 6.66, whereas the smallest amount saved was Rs. 0-4-0 by a family consisting of 4.56 persons with an earning

capacity of Rs. 27-0-0 per month. But all the saving went to the Bania, the Pathan and the Sowcar—the Sweeper himself remaining as he was—always the same, always in debt, living from hand to mouth. That is why he has no incentive for economy. If he could reap the fruit of his judicious spending, he may save and continue to save, but so long as the money-lender is at his door there will never be any improvement. The average surplus in case of those families who had any savings at all comes to Rs. 5-4-7 per family.

28 per cent of the families were having a deficit budget. It should be remembered that in calculating this surplus or deficit no account is taken of any payments made either towards the payment of interest or the principal of the debt incurred. It is the expenditure on bare living which shows that 28 per cent of the families had no means of supporting themselves and were every month having a deficit, in one case to the extent of Rs. 13-12-0, when the total earning capacity of the family, consisting of 4.66 persons, was only Rs. 28-0-0. There is only one way of meeting the deficit—borrowing. In this world of individualism, there is no one who would help a needy man to square up his budget free of any consideration, and therefore for every penny borrowed one has to pay something in return. But this something in the case of Sweepers was sometimes as much as 300 per cent interest per annum.

Indebtedness

It is said that the agriculturist farmer "is born in debt, lives in debt and dies in debt;" the same is true with equal force about the Sweepers. They inherit a debt, add to it during their own lifetime and pass it on to their children as faithfully as they do their religion, their habits and their profession. During the whole Enquiry there was only one family which was free from debt, the rest having a debt varying from Rs.200-0-0 to Rs. 1000-0-0. The average debt comes to Rs. 367.979 per family or Rs. 82.138 per person. As against an income of Rs. 37-6-7 per family per month there is a debt of Rs. 367-15-8, *i.e.*, the debt is 9.8 times the monthly income. This is a state of affairs that has persisted for a very long time, and unless energetic steps are taken to improve it and enable the worker to begin his life anew, without previous commitments, he will never be able to get out of this embarrassing position by himself.

It is difficult to believe so much debt per head, when no Sweeper would be able to offer sufficient security for getting such a big sum, and be able to pay the interest charges and regular instalments towards the redemption of the principal, out of his monthly income, unless the manner in which the debt is incurred and the interest paid is described. The money-lender parts with his money on one condition, *viz.*, that the interest shall be regularly paid, though in his own mind he realises that it cannot possibly be paid regularly out of the meagre income of the borrower. He therefore suggests a way to which a Sweeper readily agrees. "Give me all your pay," he says, "as soon as you get it ; I shall be right at the door ; I shall deduct my dues and if you find that on the amount left thereafter you cannot keep your body and soul together, you will always meet me, your friend, and ask for additional sums which shall readily be advanced to you on the same conditions." This is how the money is borrowed and the interest paid.

In some cases the interest charged was as high as 300 per cent per annum, though usually it was somewhere in the neighbourhood of 75 per cent.

A classification of the amount of debt in relation to the size of income is interesting enough to be reproduced below :—

Groups	Average Indebtedness per Family
	Rs.
Below Rs. 30	309 12 0
Rs. 30 and below Rs. 40	320 0 0
Rs. 40 and below Rs. 50	449 0 0
Rs. 50 and below Rs. 60	650 0 0
Rs. 60 and below Rs. 70	250 0 0
Rs. 70 and below Rs. 80	500 0 0
Rs. 80 and below Rs. 90	400 0 0
All Incomes	367 15 8

Having discussed the extent of indebtedness, it will not be out of place if the debt figures are analysed in respect of several causes that account for their existence. 17.45 per cent of the total debt is due to "excess of expenditure over income," 6.41 per cent to "funerals" and 71.93 per cent on account of "marriages." Only a small percentage, *viz.*, 4.21 is due to "sickness." Percentage figures for debt incurred on account of marriages are particularly very striking. Nearly 72 per cent of the debt could have been avoided or reduced had it not been for the social customs, under which a marriage, instead of being a simple happy union of two human beings, results in continuous slavery to the money-lender, because huge sums of money have to be spent in procuring a wife and entertaining one's fellow caste-men on the occasion.

Co-operative Banks have given not a little relief to the poor borrower by enabling him to obtain credit at lower rates of interest. About 55.13 per cent of the money borrowed by the Sweepers, has been taken from their own Karachi Municipal Sweepers' Co-operative Bank, where they are charged 9 per cent interest per annum. One Sweeper stands surety for another, the third for the fourth, and between themselves they divide the risk and the gain. On the 55.13 per cent debt, taken from the Co-operative Bank, the Sweepers pay 37.01 per cent of the total payments they make both to the Bank and the money-lender, whereas on the remaining 44.87 per cent debt, taken from the money-lender, they pay 62.99 per cent of their total payments.

About 8 per cent of the families could not pay anything at all either towards the interest or the capital. The maximum payment made by any family was Rs. 30-0-0 per month while the minimum payment made was Rs. 2-0-0, the average payment for each family per month being Rs. 9-12-6, *i.e.*, nearly 1/4 of the average expenditure per family.

UNEMPLOYMENT

In several cases it was reported that though there were employable persons sitting in the family, they were not able to contribute anything

towards the family income because they were out of jobs. Unemployment amongst the Sweepers is also gaining ground and one comes across many young men and women who for want of anything to do waste their time in smoking and gossiping. If the husband is employed, the wife is out of job ; when both are earning, there are other unemployed dependants who work as a drain on the family purse.

Hours of Work

A Sweeper works from 6 to 10 in the morning and again from 3 to 6 in the evening, *i.e.*, for 7 hours he toils with an interval of about 5 hours between the morning and the evening hours. Though the hours of work are not long, the spreadover is trying and the way in which the Sweeper has to work—to sweep the road, clean the latrines, enter the gutters, etc., makes the whole job very strenuous.

Place of Work

Karachi is a large city and if all the Sweepers lived at one place it would take them a great deal of time to traverse the long distances that lie between one Quarter and another. The Municipality has therefore provided Quarters for them at six different places spread throughout the city so that their place of work may not be very far away from their homes. In no case did any Sweeper report his place of work to be at a longer distance than a mile.

Housing and Sanitation

The Karachi Municipality has provided rent-free Quarters for its employees who work as Sweepers, Refuse Cart Drivers, Muccadams and Drainage Coolies at the following places :—

Ranchore Lines (Narayanpur)
Soldier Bazar
Civil Lines
Lyari
Clifton
Keamari

68.74 per cent of the tenements provided are pucca structures, made of cement, while the rest are katcha huts, made of straw and mud—that is 31.26 per cent of the Municipal Sweepers' families live in huts that can scarcely boast of any convenience. Their condition even in fair weather is bad enough, with pools of water near the entrance, animals tied to the doorstep, and dirty smell coming from latrines that stand nearby ; but during the rains, when the water rushes inside, when the roof is leaking and all the belongings lie piled up on floating cots, it is simply indescribable.

Each tenement consists of one small room with kitchen attached and a patch of common verandah. The absence of any privacy would strike even a casual observer. There are a few taps and latrines common to

all, but there is constant complaint about their inadequacy, as many of the taps do not work owing to shortage of water supply.

Of all the Quarters, those at Narayanpur are the best and the most sanitary. Those at Keamari are stinking and there is no proper arrangement even for water supply. There is a pool which twice a day is filled with fresh drinking water and every housewife rushes to fill her jar lest the children may shout for water while the vessels are empty! There is hardly any open space between one block and another, and men, women and children, and their domestic animals, the cow and the goat, all live together in close brotherhood, herded together as in a pen, which here happens to be called a compound. The members of the mosquito brigade who are paid to destroy mosquitoes in the city, provide in their own homes an eternal shelter for these disease carrying insects to grow and multiply *ad infinitum*. Curiously enough the destroyer becomes the breeder! This is at Keamari, but the conditions at the Lyari Quarters are none too better. The plight of those who live in the katcha huts behind the pucca blocks at Soldier Bazar, is just as pitiable.

Unless the Municipality provides all pucca Quarters for the Sweepers, with proper sanitary arrangements, more space between one block and another, with more taps and latrines and playgrounds, the housing conditions of these people cannot possibly be considered as satisfactory. All the Sweepers must enjoy the same facilities provided by their common employer. They must also at the same time be taught by their employer to observe sanitation in their own houses so that their professional ability, which enables them to make a living, is of some use to them also, in keeping them fit and their houses clean and tidy.

Holidays

For every Sweeper Sunday is a half-working-day. He need not go to work in the afternoon. Besides the half-holiday on Sundays, he gets 6 other half-holidays (with pay) during the year, 3 on important Muslim and 3 on Hindu Bank Holidays. He can get 10 days' casual leave with pay during a year. Likewise he can get Privilege Leave for a month (with pay) provided the Municipality does not incur any extra expenditure on that account. When he is ill, leave is granted to him, which is counted either as Casual or Privilege Leave, but there is no special sick leave permissible as in the case of other Municipal employees.

Provident Fund

After strenuous efforts on the part of the Sweepers' Union, the Municipal Corporation agreed to institute a Provident Fund for Sweepers.

The Fund was started on the 1st April 1938, the employee and the employer contributing an equal share. 6¼ per cent of the monthly income of the Sweeper is deducted on account of the Provident Fund and an equal amount is added to it by the Municipality. The Corporation places every month to the credit of the subscriber interest at the fixed rate of 5 per cent per annum calculated on the amount standing to the credit of each subscriber. As the Fund has been started only recently, no detailed Rules are yet available, but it is known that as soon as a certain amount accumulates, loans could be taken from it by the Sweepers.

After the completion of three years' service a Sweeper can withdraw a sum not exceeding three months' pay from the amount of his own contribution to the Provident Fund. The Fund serves a double purpose. After the completion of active service a person receives a lump sum, while during his service period he can take a loan any time he requires it. There is still another advantage—compulsory saving. There are very few individuals who save regularly out of their monthly incomes (it would almost be impossible in the case of Sweepers who are well known for their extravagance and careless spending) but in this case before they receive their pay a saving has been effected on their account.

Uniforms

Each Sweeper, man and woman, gets a uniform both during Summer and Winter. In Summer a man gets 2 coats, 2 pants, and one turban of 8 yards length, and in Winter one woollen jersey (every alternate year). For women there are two kinds of dresses supplied—one for Gujarati and the other for Punjabi women. In Summer a Gujarati woman gets 2 saris, 2 cholis and 2 gagras, while a Punjabi woman is given 2 ravas, 2 sulwars and 2 shirts. During the Winter they too receive a woollen jersey (every alternate year).

Trade Unionism

The Sweepers have a trade union of their own, *viz.*, The Karachi Municipal Sweepers' Union which was registered on the 5th January 1928, under the Indian Trade Unions Act, 1926. It was the first trade union to be registered in Sind and it has been functioning with great zeal ever since its start. It has a membership of 913 with an average income of Rs. 200-0-0 per month as against an average monthly expenditure of Rs. 180-0-0.

Every Sweeper, both male and female, who is in the employment of the Municipality, is a member of the Union and there are at present 313 female members on the roll. There is a uniform monthly subscription of annas four. The present Enquiry disclosed that in one case a family was contributing Rs. 1-4-0 per month as it consisted of 5 adults who were all employed. The average monthly contribution per family towards the Union funds comes to Rs. 0-6-5, *i.e.*, about 1.07 per cent of its total income.

The Union has its office in the Narayanpur Sweepers' Quarters, where under its auspices classes are held at night for the benefit of adult Sweepers. The school is quite popular and several persons take advantage of it. A free reading room and a library is also provided by the Union at the Narayanpur and the Lyari Quarters. The Union officials are always representing grievances of the Sweepers before the Municipal authorities and by their efforts a great deal has been done for them.

Life and Work

Early in the morning, they get up—the wife and the husband—take their brooms in hand and leaving their young children asleep they go to

their work, and before the town is awake, they have nearly done their job, cleaned the roads, swept them and removed the night soil and the refuse. Some do that, others go about cleaning latrines, removing water from catch pits and cesspools ; while still others with their bullock-carts and lorries rapidly move from street to street emptying dustbins, filling their carts with loads of rubbish.

While the mother and the father are away, the children wake up and under the care of an elder sister or brother, if they have any, perform their 'ablutions' and get about playing in the compound with empty stomachs. The elders have their tea, many cups of it, before they return home at 10, but the children go hungry all the while. In the absence of their parents, they play in the dust, spoiling their eyes and ears, and the youngest sit naked watching their elders perform gymnastics which they too in their time will learn so well.

At 10 the parents are back home and start preparations for their morning meal. Smoke comes from every kitchen and the housewife busies herself to satisfy the hungry look of her children. After the scanty meal is over, a little dusting and cleaning and sewing is done, and then comes the afternoon nap.

Quickly must they get up to start for their place of work again ! For another spell of three hours they toil along, and it is only with the setting sun that their day comes to a close. They move back home hungry—anxious to light their kitchen fire and to meet their little ones.

During the hours of work they have some bread and tea but their children continue to play in the dust without such an addition to their morning meal. The condition of the poor children is indeed pitiable—neglected as they are, they live in summer and winter, half clothed, ill-fed, maltreated and uncared for.

When the woman returns home, she gets busy preparing the night meal. The Sweepers have two meals, just ordinary meals, bread and a little dal or vegetable and plenty of water to swallow the food with. Only sometimes comes meat and 'pulao' ! The night meal being over, the man moves out to the neighbour's place, while the wife cleans the utensils, spreads the bed and prepares to retire. Amongst the men the 'Huka' goes round, and in smoking and talking the hours are spent, till it is the retiring hour, when every one goes home to sleep in order to be alive for the morrow.

This in short is the life of these poor Sweepers who do the noblest service to their fellow-men and yet are treated as undesirable filth by those whom they serve. Time is moving, ideas are spreading, and it will not be long before they claim their proper place in society, acknowledged as its worthy members and not mere untouchables !

APPENDIX A

Reference No..................
Date..........................
Quarter.......................

Name ....
Age ....

Birth Place ....
Cause of Migration ....
Religion ....
Nature of Employment ....
Family Composition with Ages ....
Wife ....
Male Children ....
Female Children ....
Dependants ....
Literacy (Husband and Wife) ....
Do you send your children to school ; if not, why ? ....
Hours of Work ....
Place of work and the distance it is far from home ....
Housing and Sanitation ....
Income ....
Men's ....
Women's...
Children's ....
Other income of the family besides the pay ....
Total ....
Expenditure ....
Food ....
Clothing ....
Lighting and Fuel ....
Miscellaneous ....
Alcobol ....
Cinema ....
Cigarettes ....
Others ....
Total ....
Total ....
How are the savings utilised ? ....
How is the deficit met ? ....
Indebtedness ....
Excess of expenditure over income ....
Funerals ....
Marriages ....
Total ....
Amount taken from Co-operative Bank ....at ....p.c.
Amount taken from the Money-lender ....at ....p.c.
Payments to the Co-operative Bank (both towards interest and capital) ....
Payments to the Money-lender towards interest...................................
towards capital.................................
Total...

Total payments

Trade Union Membership Subscription paid by the Family ....
General Remarks ....
....
....
....

SOME TAMIL FOLK-SONGS

(Continued from Previous Issue)

By

M. N. SRINIVAS, M.A., LL.B.,

Research Assistant in Sociology, Department of Sociology, University of Bombay

SONGS OF MARRIAGE AND FAMILY LIFE

THE song sung by the Panḍāram (non-Brāhmin priest) at a Paryyan wedding contais reference to the 'Vēdās, and those who have studied the Vēdās', pointing to the penetration of the Sanskritic culture into the Paryyan stratum. The marriage post of the peepul (*ficus religiosa*) tree is worshipped elaborately, and the importance attached to the marriage post appears to be common to the Non-Brahmin castes of South India.[1]

The maternal uncle seems originally to have had the authority to hand away a girl in marriage even against the express wishes of the girl's parents and brothers. One cannot say that this is even now the custom. But, on questioning the Paryyans, I found that even now the maternal uncle has a great deal of power over the disposal of the girl.

The ideal wife is one who is chaste, mild and obedient. Barrenness is a great curse, and *tapas* is performed to obtain children. Offerings are given to deities, and vows undertaken towards the same end. Though adoption is prevalent, it is not very popular, the loyalty (to the adoptive parents) of even an *aṇṇan's* or an *akka's* son being doubtful.

A good many songs (some of them have appeared under the *Koḍumbāvi pāṭṭu*) bemoan the husband's death, though there is not one sung by the husband at his wife's death. The reason for it is hard to understand, though we know that *oppāris* or wailing songs are sung only by women-folk. Men seem to specialise only in singing love songs, boat songs, etc. If the answer is that the widow's lot is too terrible a one, then one has to reply that among the non-Brāhmin castes, especially where Sanskritic influence is the least, widow marriage is very common, and her lot, therefore, is not as bad as among the Brāhmins and the other "upper" castes. There is only one song describing the *sumangali's* death, and another describing *sati*.

Among Tamil women, all the castes use turmeric while bathing; turmeric stands for *sumangalihood*, and turmeric paste signifies and sanctifies any auspicious ceremony. Turmeric is used widely in South India, and the higher the caste the greater is the reverence paid to it by women. The Tamil non-Brāhmin women also use it while bathing. Whence

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1 See the Author's ***Marriage and Family in Mysore***, chap. VIII, p. 91, *infra*.

arose this respect, etc., for turmeric? Was it original to South India, and was it carried thither by diffusion? All these open up great vistas of fruitful inquiry.

MARRIAGE SONGS

The following song is sung by the Panḍāram (caste) priest at a Paryyan ("Untouchable") wedding.

Tamil	*English*
1. Śandanattāl tare mu*l*agi*,	1. Smearing the floor wth sandal-paste,
ivargaḷ śandanattāle kōlamiṭṭu,	these two drawing *kōlam*[1] designs with sandal,
vā*l*avēnḍu, ivaragaḷ vā*l*avēnḍu,	(those two) should prosper, these two should prosper,
ivargaḷ mahārājanāga vā*l*avēnḍu.	these two should live as *mahārājas*.
2. Āle pōl ta*l*y tōngi, ivargaḷ arugadu pōl vērōḍi,	2. (These two should be) prosperous like the banyan, spread roots (wide) like *aruga* grass,
mūngily pōl kuruttōḍi, ivar muruganeppōl vā*l*avēnḍu,	shoot up like the bamboo, these (should) live like Muruga (Subrahmaṇya),
vāśal idu, vāśal idu, mahārājan vāśal iḍu.	this is a door, this is a door, this is the *mahārāja's* door.
3. Aṇṇanum tambiyamāi aḍakkaḍukāi vā*l*avēnḍu,	3. Like elder and younger brother,[2] like pots one kept on another,[3] should prosper,
āḍalāl vā*l*ge, vā*l*ge, arandapa munivar vā*l*ge,	therefore prosper, prosper, like *rishi* who have done great penance,
vēdamum vā*l*ge, vēdiyar kulattōr vā*l*ge,	let the *vēdās* prosper, let the people of the *vēda kula* (Brāhmins) prosper,
būdalattōrgaḷ vā*l*ge, puṇṇiya kulattōr vā*l*ge,	let those on this earth prosper, let those who have done good deeds prosper,
inda māpiḷḷeyum peṇṇam makkaḷ padinārum peṯru peru vā*l*uvā*l*ge.	let this son-in-law (and) girl, with sixteen children born, prosper greatly.

ŚŌBANAM PĀṬṬU

Sung when the bridal pair is circumambulating the *peepul* (*ficus religiosa*) post in the marriage pandal.

Tamil	*English*
1. Śōbanamām, śōbanam, śuba śōbanattama pāḍuvē,	1. It's *śōbanam*,[4] *śōbanam*, (we shall) sing in Tamil (about) good *śōbanam*,
ā peṇgaḷ śōbanam, accuta peṇgaḷ śōbanam,	those girls' *śōbanam*, good girls' *śōbanam*,

*l has been used for the sound 'zh' as in 'kuzhavan.'

1 *Kōlam* designs are drawn daily in front of the house with the powder of a soft kind of stone. During festivals a solution of rice-flour is used to draw designs with, on the floors and walls of the house. There is a pleasant exaggeration here in mentioning that it should be drawn with sandal-paste, and the floor, usually cleaned with cowdung, to be also cleaned with sandal-paste.

2 Means as harmoniously as two brothers.

3 Has a double meaning, one, as intimately as pots, one kept on the other; and the second, 'let the generations, each represented by a pot, prosper.'

4 Śōbanam, probably from śubha.

Tamil	*English*
śōbanammā śōbanam śuba śōbanattama pāḍuvē,	it's *śōbanam*, etc.,
māmaramām vanni maram, mannār kōvil tennammaram,	it's a mango tree, a *vanni* (*prospis spicegara*) tree, there's a coconut tree in *mannār kōvil*,[1]
māṇikka rattinakkāl naṭṭi, puṣpam vastirattāl vaḷy pūṭi,	(we shall) plait the coral, diamond pillar,[2] with flowers, clothes (decorate) and put bangle,
āṇi pavaḷattāl śedyiṭṭu, adan mēl pacce nīlam parappi,	with good coral plait the hair, and spread emerald, sapphire,
tangattagaḍugaḷ tān aṇindu, muttu śarangal śuṭṭiyam tān aṇindu,	drape it with gold sheets (and) twining pearl necklaces round it,
engum śōbanamām, śōbanam.	our *śōbanam*, etc.

The Unhappy Wife

The following song is sung by a girl who is not having marital happiness either because the husband is impotent, or has some other defect. We find it mentioned in the song that the girl was given away in marriage by her maternal uncle (who was bribed with a pot of toddy) even against the wishes of her parents and brothers. The question immediately arises, whether the maternal uncle has such powers in real life. I, however, found this joke about the maternal uncle nodding his head in agreement to the proposal for his niece, when under the influence of drink, a much-told one. In another version, I have it that the befuddled father nodded his head in agreement.

Tamil	*English*
Pinnattūr veṭṭiyānam pinne randa śēva varam,	The watchman of the graveyard of Pinnattūr, behind him two servants,[3]
peṇ kētka vandārgaḷ.	came to ask for a bride.
ānykaṭṭam aṇṇanmār āgādu enrārgaḷ,	*annans* (elder brothers) capable of tying up elephants said 'no,'
kudurekaṭṭam tagappanār kodukkamāṭṭe enrārgaḷ,	father capable of tying up horses said ' I won't give,'
taraṇi āḷam tambimāraḷ takarār śydārgaḷ,	*tambis* (younger brothers) capable of ruling the earth created a row,[4]
tangamaṇi tāyār takarār śydārgaḷ,	gold-bead mother created a row,
orumando kaḷḷukku en māman oppudal koḍuttāngo !	(but) for one mud vessel of toddy the *māma* gave his agreement !

Married Life

In the poem below a woman complains to her grandmother about the utter unreasonableness of her husband, and how he makes her existence miserable.

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[1] From which the town of Mannārguḍi takes its name. There is a temple to Rājagōpālaswāmi here.

[2] The *peepul* pillar, *araśāni kambam* as it is called, is of great importance in marriage ritual. Here the pair are worshipping it.

[3] Obviously indicative of the high status of the bridegroom's family !

[4] They also did not agree to the match.

Tamil	*English*
1. Kāl paḍi kambaraśi, ammāyi, kālu oḍinja kōli kunju, kāla kari poḍalennu, karūrānḍi śāmattile, nānanāna nannānā, etc., viṭṭy vanda kōvandiram, ammāyi, ūre pōnāl nyāyandirum, nāna, etc.	1. A quarter *paḍi*[1] of *kambu* grain, grandma, a chicken with a broken leg, that I did not serve him curry made of its leg,[2] he raves at me during midnight, *nāna*, etc., if he comes home his anger will pass away, grandma, if he goes out of the village, he will know what justice is, *nāna*, etc.
2. Arappaḍi kambaraśi uruvilla kōli kunju nāna, etc., oḍulu kari pōḍalennu, odakirānḍi śāmattile, mukkāpaḍi kambaraśi, ammāyi, mūkkuḍinda kōli kunju nāna, etc., mūku kari pōḍalennu, ammāyi, mūkkuranḍi śāmattile nāna, etc., viṭṭyvanda kōvandiram, ūre pōnāl nyāyandiram nāna, etc.	2. Half a *paḍi* of *kambu* (and) a wretched chicken, *nāna*, etc., (that I) did not serve him with its intestine curry, he kicks me during midnight; three-fourths *paḍi* of *kambu*, grandma, broken-nosed chicken, *nāna*, etc., (that I) did not serve him with nose-curry, grandma, at midnight he makes a hoarse guttural noise, *nāna*, etc., if he comes home, his anger will go away, if he goes out of the village, he will see what justice is, *nāna*, etc.
3. Oru paḍi kambaraśi, ō, ammāyi, oru śaṭṭi raśam vyttēn, nāna, etc., andu raśam pattalennu anḍe viṭe kētārandi, viṭṭy vanda kōvandiram, ō, ammāyi, ūre pōnā nyāyandiram, nāna, etc.	3. One *paḍi* of *kambu*, o, grandma, one pot of soup I kept, *nāna*, etc., (complaining) that it was not enough, he asked for some from the neighbours, if he comes home his anger will go away, ō, grandma, if he goes out of the village, he will see what justice is, *nāna*, etc.

THE AWFUL WIFE

The song below describes a wife who is awful in every way. It is said to be a humorous song, the humour obviously consisting in making her the opposite of the ideal. The ideal is the chaste, obedient and mild wife. The song was collected from the Paryyans.

Tamil	*English*
1. Peṉjāti nallavaḷayya, enukku vālta samsāram nallavaḷayya, ennoḍeya peṉjāti enakkora puḷḷy peṭrāḷ, en māmanokku oru puḷḷy peṭrāḷ, en maccanokku oru puḷḷy peṭrāḷ, en appanokku oru puḷḷy peṭrāḷ.	1. (My) wife is a very good (woman), the wife I have got is good, my wife delivered me a son, she delivered a son to my *māma*,[3] she delivered a son to my *maccān*,[4] she delivered a son to my father.

[1] *Paḍi* is the local measure, about ¾ of a seer.

[2] The husband is so unreasonable that he demands the leg of a lame chick. Also he wants dishes from all the impossible parts of the chick's anatomy.

[3] Maternal uncle.

[4] Sister's husband, wife's brother, etc.

Tamil	*English*
2. Enḍi enru kēṭṭu viṭṭāḷ, eḍuttu koḷvāḷ tuḍapukaṭṭy,	2. If I ask her 'why,' she will take up the broom (to beat me with),
en peṇjāti nallavaḷayya,	my wife is a good (woman),
ennoḍeya peṇjāti irandu irandu puḷḷy perpāḷ,	my wife delivers babies at long intervals,
ennoḍeya peṇjāti nallavaḷayya.	my wife is a good woman.
3. Ennoḍeya peṇjāti eḍurta viṭṭuku śanḍeki pōvāḷ,	3. My wife goes to the opposite house to pick up a quarrel,
eḍurta viṭṭu peṇ ēmāndāl aḍittum viḍuvāḷ,	if the girl in the opposite house is careless, (my wife will) even beat her,
ennoḍeya peṇjāti nallavaḷayya.	my wife is a good (woman).

The Baby and the Moon — A Lullaby

The song is in the form of a conversation between the Baby and the Moon.

Tamil	*English*
B: Nilāve, nilāve, enge pōnāi nilāve ?	B: Moon, Moon, where did you go, O Moon ?
M: Maṇṇan kuḷattakku mannedakka pōne.	M: I went to the pond to get some mud.
B: mannu ēn, maṇṇu ēn ?	B: why mud, why mud ?
M: ulakku paṇṇa, ulakku paṇṇa.	M: to make a vessel, to make a vessel.
B: ulakku ēn, ulakku ēn?	B: why vessel, why vessel ?
M: paṇam pōda, paṇam pōda.	M: to put money in, to put money in.
B: paṇam ēn, paṇam ēn ?	B: why money, why money ?
M: māḍu vānga, māḍu, vānga.	M: to buy a cow, to buy a cow.
B: māḍu ēn, māḍu ēn ?	B: why cow, why cow ?
M: śāni pōḍa, śāṇi pōḍa.	M: to get cowdung, to get cowdung.
B: śāṇi ēn, śāṇi ēn ?	B: why cowdung, why cowdung?
M: vīḍu mu*l*aga, vīḍu mu*l*aga.	M: to clean the house with, to clean the house with.
B: viḍu ēn, viḍu ēn ?	B: why house, why house?
M: puḷḷy pera, puḷḷy pera.	M: to have a son, to have a son.
B: puḷḷy ēn, puḷḷy ēn ?	B: why a son, why a son?
M: paḷḷikuḍattil tuḷḷi vaḷiyaḍa, gilu, gilu, gilu, gilu.	M: to jump about (and) play in the village school, *gilu*, etc.

Songs of Barrenness

In the song below we hear the wail of a barren woman. There is a reference to the 'five rulers of pānḍia' which, if taken literally, means the Pānḍyan Kings who ruled at Madura. The reference to Kaṇṇagi in the first line may also confirm this view. Kaṇṇagi is the heroine of the Tamil classic, Śilappadikāran, and she was responsible for the burning of Madura. But Kaṇṇagi is also used to mean a girl, or a virgin, or in this connection, a virgin deity. And if we read Pānḍava for Pānḍia the song may be taken to mean the wail of Draupati.

Probably this song is sung in chorus, the latter half of the first line common to all the lines, being the portion sung by everyone, and the first half sung only by the leader of the chorus.

Tamil	*English*
1. Miḷyga nalla niratti vyttu, ē kaṇṇagi, ē āmāmbō, metta tapam śydu vande, ē āmāmbō, appaḍiyam piḷḷy ille, ē āmāmbō, ivar rāja pānḍiyar ku, ē āmāmbō.	1. I made pepper stand well, O virgin, ō, it is so, go,[1] I made great penance[2], ō, it is so, go, even then no child, ō, it is so, go, for the five *Pānḍian* Kings, ō, it is so, go.
2. Kaḍugy nalla niratti vyttēn, ē āmāmbō, kanattapam śydu vande, ē āmāmbō, appaḍiyam piḷḷy ille, ē āmāmbō, ivar rāja pānḍiyarku.	2. I made mustard stand well, ō, it is so, go, I made great penance, ō, it is so, go, even then no child, ō, it is so, go, for the five *Pānḍian* kings.
3. Iruḷaḍenda kōvilakku, ē āmāmbō, eṇṇe koḍam anapi vittēn, ē āmāmbō, appaḍiyam piḷḷy ille, ē āmāmbō, ivar rāja pānḍiyarku.	3. To the darkness-filled temple, ō, it is so, go, I sent a pot of oil,[3] ō, it is so, go, even then no child, ō, it is so, go, for the five *Pānḍian* rulers.
4. Pā*l*eḍanda kōvilakku, ē āmāmbō, pālukoḍam anapi vittēn, ē āmāmbō, appiḍiyam piḷḷy ille, ē āmāmbō, ivar rāja pānḍiyarku.	4. To the ruined temple, ō, it is so, go, I sent a pot of milk, ō, it is so, go, even then no child, o, it is so, go, for the five *Pānḍian* rulers.

A mother mourns for her son who has no son. And she also objects to taking anyone's child in adoption.

Tamil	*English*
Tēngā nalla mu*l*i a*l*agā, mu*l*i a*l*agā,	With eyes like good coconuts, beautiful eyes,
ten madure pānḍiyanḍī, pānḍiyanḍī,	(you who are) like the Pānḍia (king) of Madura, in the South,
māngāi nalla mu*l*i a*l*agā, mu*l*i a*l*agā,	with eyes like good mangoes, beautiful eyes,
vaḍa madure pānḍiyanḍī, pānḍiyanḍī,	like the Pānḍia (king) of North Madura,
piḷḷy illy enra śolli, enra śolli,	'no son have I,' (she) says,
pu*l*umburale varṇamāly, varṇamāly,	Varnamāle (daughter-in-law) wails, Varnamāle,
gōpuratte śuṭṭiyallō,	(I) went round the temple tower, (I) went round,
kuḍavaḷakku ētti vyttēn, ētti vyttēn,	I lighted a *kuḍavaḷak*,[4] I lighted,
appaḍiyam piḷḷy illy, en arumeyāna manganukku,	even then no child, for my beloved son,
manḍapatte śuṭṭiyallō, śuṭṭiyallō,	I went round the *manḍapam*,[5] I went round,
maṇivaḷakku vāngi vyttēn, vyttēn,	I offered beautiful lamps (to the deity), I offered,
appaḍiyam piḷḷy ille, piḷḷy ille, en arumeyāna kumāranakku.	even then no child, for my beloved son.

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1 This is said in a long drawn voice, and it denotes not mere affirmation of the speaker's statement, but also indifference towards it.

2 Perhaps the penance was so great as to make pepper and mustard stand on a needle.

3 Pots of oil, ghee and milk are sent as offerings to deities. A favourite form of propitiation.

4 *Kuḍavaḷak* is also an offering peculiar to South India. A stout cotton wick is dipped into a pot of ghee or oil, and it goes on burning for hours. A favourite form of propitiation.

5 Central hall inside the temple compound.

Tamil	*English*
Akkā vīṭṭu piḷḷy irandāl, piḷḷy īrandāl,	If there were children in *akka's*[1] house, if there were children,
onnu ranḍāi vaḷartumē, vaḷartumē,	one or two could have been brought up (by my son),
akkā vīṭṭu piḷḷy yānāl, piḷḷy yānāl,	but children in *akka's* house, those children,
aḍivarappam pāmballavō, pāmballavō,	(if adopted) even the boundary would become a snake,[2] a snake.
aṇṇan vīṭṭu piḷḷy irandāl, piḷḷy irandāl,	if there were children in *aṇṇan's*[3] house, if there were children,
onnu ranḍāi vaḷartumē, vaḷartumē,	one or two could have been bourght up (by son),
aṇṇan vīṭṭu piḷḷy yellā, piḷḷy yellā,	but *aṇṇan's* house children, they all,
aḍivarappam pāmballavō, pāmballavō.	(if adopted) even the boundary would become a snake.

THE HUSBAND'S DEATH

One of the most common themes we run into in these folk-songs is the husband's death. And it is a matter for surprise why we do not hear the husband wailing the dead wife.

Tamil	*English*
1. Śōḷam pori porittu,	1. Parching *jowar*,
śokkaṭṭān tērgaṭṭi,	build a clean *tēr*,[4]
śuḷḷāṇi illāde,	(but) without axle,
śuyaludē ponḍēru.	the gold chariot stays without moving.
2. Pūndērukku uḷḷāle,	2. Inside the gold chariot,
puṇṇiyare ēttiviṭṭu,	seated the merited one,[5]
andu puṇṇiyarum pōna nēram,	(and) in the wake of the merited one's departure,
pu*l*adi peraḷudē.	(I) roll in the street-dust !
3. Kambu pori porittu,	3. Parching *kambu*,
kākattān tēru gaṭṭi,	build a chariot with *kākāṭṭān* flowers,
oru kaḍeyāṇi illāde,	(but) without the axle,
ka*l*aludē ponḍēru.	the wheel of the gold-chariot loosens away.
4. Mādatte kaṭṭiyallō,	4. (You) built a house,
myl e*l*adiviṭṭu,	(you) had a peacock drawn (on the wall),
māḍam murundudenna ?	the house is there (no doubt),
anda mylu pōna māyamennā ?	but how did the peacock manage to disappear ?
5. Kūḍatte kaṭṭiyallō,	5. (You) built a nest,
kuyile e*l*adiviṭṭu,	(you) had a cuckoo painted,
kūḍam irandudenna ?	the nest is there (no doubt),
anda kuyilu pōna māya mennā ?	but what is the magic of the cuckoo's disappearance ?

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[1] *Akka* is elder sister, whether of speaker, or her son is not clear.

[2] Other's children cannot be trusted. They may all try to deceive. The boundaries of paddy-flats are just ridges several inches high, and they resemble snakes. The expression means a betrayer of trust.

[3] *Aṇṇan* is elder brother.

[4] *Tēr* literally means a juggernaut. Here it refers to the bamboo pier in which the dead husband is seated.

[5] Husband is referred to in these terms.

SAHAGAMANA, OR SATI SONG

The song is sung while transplanting paddy, one woman singing the song, while the others shout 'o' at the end of every line. I learn that this transplantation work is done by women.

Tamil	*English*
Oru vārtekku oru vārty ō pōḍavēnḍum,	For one word (from me), (you) should reply another word 'ō',
oru paḍi pacce manśaḷ, ō,	one *padi* of fresh turmeric, ō,
oru mādam pādam paṇi, ō,	one month job of tanning leather, ō,
uryttu kuḷikkailē, ō,	rub the turmeric root[1] (and) bathe, ō,
oyil būmi āḍaile, ō,	when playing on delightful earth, ō,
poi vārēn kāśinādā, ō,	I will depart, Lord of Kasi,[2] ō,
pungavanam ti kuḷikka, ō,	to bathe in the fire (pit) in the flower-garden, ō,
kāraśira piḷandu, ō,	splitting hard fuel, ō,
kylangiri ti vaḷattu, ō,	to create *Kailas* fire,[3] ō,
kaṇṇāḷane koḷḷi vyttāl, ō,	if burn my husband-lover, ō,
karpūram pōl ninrareyum, ō,	(he) will burn like camphor, ō,
śūra śirā piḷandu, ō,	splitting *śūra* fuel, ō,
śuḍale kare tīvaḷattu, ō,	create fire in the burning-ground, ō,
śundarane koḷḷi vyttāl, ō,	if I burn my beautiful (husband), ō,
śūḍambōl ninrareyum, ō.	(he) will burn like camphor, ō.

ŚĀNDIḌIKIRA PAṬṬU

The following songs are sung by girls when they are preparing *śāndu*, a black paste, a round dot of which adorns the foreheads of young girls. To prepare it is a hard process involving pounding with a long pestle, a mixture of chunam and *sonde*. The girls who are pounding in the sun abuse the carpenter and his assistant who prepared the stout pestle, and who are resting in the shade.

Tamil	*English*
1. Kottanārē, en śāmi, śittargaḷa, ē, ām-āmbō,	1. Carpenter, my lord, his assistants, ō, it is so, go,
guṇamum konja ongaḷukku eranga vēnḍum,	you should have a little pity on us,
punga nalla, en śāmi, vēr irandu, vēr kiḷandēr, ē āmāmbō,	good *punga*,[4] my lord, cut its root, uproot it, ō, it is so, go,
puṇṇiyavān, en śāmi, sydolakke,	merited one,[5] my lord, the pestle he made (from *punga* tree),
āla nalla, en śāmi, vēr kiḷandu, ē ām-āmbō,	good banyan, my lord, uproot it, ō, it is so, go,

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[1] Turmeric roots freshly dug up from the earth are rubbed against a stone, and the resultant yellow paste is rubbed all over the body during bath. Women (*sumangalis*) of all the castes use it.

[2] Viśvēśwara.

[3] Probably means the fire that takes one to *Kailas*.

[4] *Pungamia glabra.*

[5] The term *punniyavān* is used ironically.

Tamil	*English*
erumbāvi, en śāmi, sydolakke, ē ām-āmbō,	the great sinner, my lord, the pestle he made, ē, it is so, go,
kālayile, en śāmi, vandōm śāmi,	in the morn, my lord, we came, lord,
kālapuṇṇāi, en śāmi, nōvudayyā,	blisters in our feet, my lord, hurt,
viḍiyakālam, en śāmi, eḍatolakky,	early morning, my lord, the pestle we lifted,
veraḷu puṇṇāi pengalakku pōvudayya,	(the) girls' fingers will have blisters,
visuvumēle, en śami, nīngaḷirka,	(while) on a bench, my lord, you are sitting,
viḍumburōme, en śāmi, vyyalile,	we suffer, my lord, in the sun,
kaṭṭil mēle, en śāmi, ningaḷirka,	(while) on the cot, my lord, you are sitting,
kaśangurōme, en śāmi, vyyalile,	we wither, my lord, in the sun,
ne*l*alile, en śāmi, ningaḷirka,	(while) in the shade, my lord, you are sitting,
nikkurōme, en śāmi, nāngaḷellā,	we stand, my lord, we all,
kallāne, en śāmi, ungaḷ manam,	stone, my lord, your mind (heart) has become,
kalankalyyō, en śāmi, engaḷmīdu.	does not it melt, my lord, at our (plight)?
2. Śānd iḍikira peṇgaḷa,	2. Girls who are pounding *śāndu*,
śambaḷam ennāḍi tandāru ?	what pay are you given (for your work)?
marude tukkāṇi, ranḍaṇa kāśu,	Madura *tukkāni*,[1] pies worth two annas,
manje urokkam porādu.	not enough even to buy fresh turmeric for bath.

All the songs below are sung while pounding *sānd*, though they all together do not form a whole, and often each song is an independent entity.

Tamil	*English*
1. A*l*aga rūpatiyē, anna rati kaṇṇagiyē,	1. Beautiful girl, swan, Rati,[2] virgin,
naḍyilē nīlavarṇa paduma sundariyē,	(you) walk, blue-coloured lotus, beautiful girl,
naḍandu vā*l*ē, viṭṭy pōvum, pūvālalangāri.	come awalking, (we) shall go home, (you) flower-decked girl.
2. Kūndal vāri, kōḍeḍattu kunguma poṭṭamiṭṭu,	2. Combing the hair (and) parting it, (and) wearing the vermillion mark,
pūmuḍikkam nēramilly, ponnurata mēri,	(there is) no time to stick flowers (in hair), sitting in the gold chariot,
pōnadum tirumbiduvāḷ en pūvālalangāri.	my flower-decked girl who has gone will return.

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[1] *Tukkāṇi* is worth four pies. Probably the reference is to Mangammāl, Queen of Madura. The coin was minted during her reign.

[2] Rati, the wife of Manmatha.

Tamil	*English*
3. Tirumbi varuvudeppō, on tirumugutte pārpudeppō ? marandu irpudeppō ? mādam onrāgavilly, mangiliyam pūṭṭinadu manśaḷ kureyavilly.	3. O, when[1] are you coming back, when shall I see your god-face ? O, when am I going to forget you ? not even a month has passed,[2] even the turmeric on the *māngalyam* has not lessened.
4. Candire pera *al*agā, śangarambu vill *al*agā, vill vaḷykka ponāroḍi inda taruṉattily, viḷeyāḍa nēramiḷḷy nān pōra payeṉattile.	4. You beautiful one with the crescent moon forehead, with a red sugarcane bow,[3] at this time I go to aim the bow at someone, (and) I have no time to play with you as I am on my journey.
5. Veḷḷi malyvīdiyile, vēlvi śyvanuntagappan, śēyam tavam kulyyam, śīkkiram varam śonnār, śendanalāl vīsivadu ellā tuyarmānāl.	5. In silver hill[4] street, your father is doing *tapas*, the *tapas* will be spoilt, (he) asked (you) to come soon, (breeze of ?) red fire will 'blow if it is grief.
6. Tāmbūlam tarikkavilly, tappumēḷam pōgavilly, pandal pirikkavilly, pattunāḷ āgavilly, pārtirandu anuppanāne indiram tōdōle.	6. (He) has not chewed the *pan*,[5] the tom-tom is not gone yet, the pandal is not pulled down yet, it is not ten days yet,[6] Indira sent a messenger to fetch him.
7. Engaḷ śāpam pollādu, īśam śāpam pollādu, nāḍam kēṭṭupāru, yārukkum oppādu, nāśamāi pōviḍuvāi, śonnadum tappādu.	7. Our curse[7] is evil, god's curse is evil, you ask the country, none will agree (to this injustice), you will be destroyed, what we said will not be falsified.
8. Vāśikkum pustagamē, mānattu nakṣattiramē, marupaḍārattinamē, en manamalarnda śaṉbagamē, on manadu irandāl pōdumaḍi en arume sundariyē !	8. My reading-book, O star of the skies, O, flawless gem, my beloved flower, it is enough if you like me, O my beloved beauty ! [8]
9. Panśaṉymēl enne viṭṭu, pattāmu nī pōnāl, svapnam pōle vandu, doreyē vandiḍuvēn, taṭṭiye*l*piḍuvēn, nīngaḷum pōiviḍulāma?	9. Leaving me on the quilt (on which we slept), if you, lover, go away, I will come like a dream, my king, I will come, I will wake you with a tap, is it right for you to go away ? [9]

[1] This song is sung by a girl who has lost her husband within a month of the marriage, and

[2] even the turmeric on the marriage-bond has not diminished !

[3] Probably she compares her dying husband to Manmatha with the sugar-cane bow.

[4] Silver Hill is probably *Kailās*.

[5] The poem reverts to the theme of the loss of husband very soon after the wedding ceremonies.

[6] Before the British introduction of the postal service, the recognised mode of carrying a message was to send with the servant a letter written on palm-leaf. Indira is supposed to have sent such a servant to fetch this man.

[7] Widow's curse.

[8] This poem is addressed by the lover to the loved.

[9] The woman addresses her lover.

Death Song

The following song describes the death of a woman, and the carrying of the corpse in a well-decorated bier to the burial-ground. The woman died a *sumangali*, and commanded the respect of the neighbours.

Tamil	*English*
Nāṭṭileyum nalla nāḍu, ange pēru pōna cidambaramām,	Good *nāḍ*[1] among the *nāḍs*, there the famous Cidambaram,
pēru pōna cidambarattil, ange perumeyā tiruvakkuḷam,	in famous Cidambaram, the great sacred tank,[2]
ellārandān pōgum va*l*i, ange anēka mareśśāle va*l*i,	(it is on) everyone's way, there are many avenues,
inda pennāḷtān pōgum va*l*i, nalla pēru pōna tiruvakkuḷam,	the way this girl goes, the famous sacred tank,
terke randāḷanapi, ammāḷukku tenne maram kondu vandu,	sending two servants to the south, bringing coconut plants[3] for the mother,
vadako randāḷanapi, vāly maram kondu vandu,	send two servants to the north, bring plantain trees,
mērke randāḷanapi, mungil maram kondu vandu,	send two servants to the west, bring bamboo branches,
ke*l*ke randāḷanapi tennam kīṭrugalam,	send two servants to the east, bring mat of palm leaves,[4]
taccanyttān a*l*atuvandum, a*l*atavandum, tērgalam alankarittu,	bringing the carpenter, decorate the bier,
vannānettān a*l*atu ammāḷukku kannāḍi mēl pavittu,	bringing the coppersmith, and placing mirrors (at the top of the bier),
kaḷvinallā kuḷippāṭi ammāḷe kaṭṭādy varindu gaṭṭi,	bathe the mother well, and tie the *kaṭṭādy* (sari) firmly,
uruvinalla kuḷippāṭi, ammā uḷḷāḍy varindugaṭṭi,	massage and bathe the mother, and tie the *uḷḷāḍy* (inner garment),
aḍittu kondāḷ maradanile, ammāḷukku āṭrangary tūparakka,	she(?) beat her breasts, while the dust sprayed onto the mother at the river-side,
kutti kondāḷ māradanile, ammāḷukku kuḷatangary tuparakka,	she beat her breasts, while the dust sprayed onto the mother by the pond,
orāmbaḍi randambaḍi munāmbaḍi nāḷyyile,	one step, second step, third step[5], *nāḷyyile*,[6]
munāmbaḍi nāḷyyile ammāḷukku mudal pūśy śaigyyile,	third step *nāḷyyile*, worship the mother first,
nāḷāmbaḍi anjāmbaḍi ārāmbaḍi ēḷāmbaḍi,	fourth step, fifth step, sixth step, seventh step,
ēḷāmbaḍi nāḷyyile puśy śaigyile,	seventh step *nāḷyyile*, do pūja,
eṭṭubaḍi pattubaḍi pattāmbaḍi śēre.	eighth step, ten steps, (we) reach the tenth step.

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1 *Nād*, an administrative division of the country, common to the entire South India in former times.

2 Tiruvakuḷam ('sacred tank') was formerly the name of the village which is to-day, Annāmalainagar.

3 Very young coconut plants are used to decorate the bier, among the Non-Brāhmin castes.

4 Plantain stems, bamboo branches, and palm leaves woven into a mat, are all used for the bier.

5 Probably the bier-carriers are measuring their steps.

6 Cannot be translated.

Māśi Magam Song

Māśi Magam (*makha* constellation in the month of *Kumbha* or Aquarius, *i.e.*, the full moon day in the lunar month of *Māgha*) is a great day for river- and sea-bathing. Brāhmins offer oblations of gingelly and water to their dead ancestors after a dip in the river or sea. The Mahāmaga-kuḷam tank in Kumbakōṇam is visited on this day, and once in every twelve years, pilgrims from all parts of India flock into it for a sin-removing dip. Waters from all the sacred rivers are supposed to be present that day in the Mahāmagakuḷam.

The Non-Brāhmin castes simply go to the sea for a bath, and probably, the following song (fragmentary) is sung on the way to the sea. The song is sung by a woman, and it shows her to be wanting eagerly to invite her brother, etc., to a feast she has cooked.

Tamil		*English*	
Vengāyam karuvapile,	lēlangaḍilēlō,	Onions, *karuvapile*,[1]	lēlaṅgaḍilēlō,
engaḷaṉṉaṉ kaṉakupiḷḷy,	,,	my *aṉṉaṉ* is an accountant,	,,
kaṉakuppiḷḷy vāśalile,	,,	at the accountant's door,	,,
annam veḷe yāḍudē,	,,	swans do play,	,,
āṭṭy arattuviṭṭu,	,,	(after) cutting the goat,	,,
āṭṭelamby rasam viṭṭu,	,,	(and) making soup with its bones,	,,
āśe uḷḷa aṉṉān māre,	,,	my beloved *aṉṉaṉ*,	,,
āre viṭṭu kūpaḍavēn,	,,	whom shall I send to invite him ?	,,
māṭṭy arattu viṭṭu,	,,	after cutting the goat,	,,
māṭṭelambi rasam viṭṭu,	,,	(and) making soup with its bones,	,,
āśe uḷḷa māmanāre,	,,	my beloved *māma*,	,,
āre viṭṭu kūpaḍavēn,	,,	when shall I send to invite him ?	,,
kō*l*i arattu viṭṭu,	,,	(after) cutting the hen,	,,
kō*l*i elamby rasam viṭṭu,	,,	(and) making soup with its bones,	
en guṇam uḷḷa koyandanāre,	,,	my good husband's brothers,	,,
āre viṭṭu kūpaḍavēn,	,,	when shall I send to invite them ?	,,
āttōram koḍikālām,	,,	on the river-bank (is the) betel-garden,	,,
arambaramba vettaleyām,	,,	(there are) beautiful, serrated betel leaves,	,,
koḍi koḍiyāl vettaleyām,	,,	(there are) bunches (and) bunches of betel,	,,

Boat Songs

The following two songs are sung by the boatmen while at their work. The first one is probably a big boat, running a boat-service from Negapatam to Singapore, and the second, a small river boat.

[1] The fragrant leaves of the plant are used to flavour soup.

Tamil	*English*
1. Oru milagām, tirumiḷagu, vallānginā̄ṭi,	1. One pepper (grain), beautiful pepper (grain), (we shall) plant (our) flag,
vallāra ōli magaḷy śanḍekku alettu,	dragging to a quarrel the promiscuous daughter of the prostitute,
agapaṭṭa vaṇṇāne kūpiṭṭu alettu,	bringing in the available washerman,
āru mādattiya tiruḍany kyra tiraci,	twistnginto a rope the six-month thief,[1]
vykkōl turumbāle pōi pāḍe kaṭṭi,	building a false bier with straw,
ōḍivandu mukanyilē kaṇṇāḍi pāttu,	running in (and) peeping into the mirror in the corner,[2]
konja kaḍal pōga ile koḍimaran nāṭi,	planting flag after going a little way into the sea,
naḍu kaḍal pōga ile nangūram pāci,	throwing anchor when entered mid-sea,
nāttinā kappalile nangūram pōṭṭu,	anchoring the boat of (my) *nāttinā*,[3]
mūttāru kappaly kōḍile taḷḷi,	driving into a corner the boat of (my) *mūttār*,[4]
ōppaḍiyāḷ kappaly ōtiviṭṭu taḷḷi,	push it, while running, the boat of (my) *ōppaḍiyāḷ*,[5]
māmanār kappaly maḍagile taḷḷi,	push into a deep pool the boat of (my) *māma*,
śirunellam perunellam śirīḷa śamba,	small paddy, big paddy, (and) *śamba* grain,[6]
karumanśaḷ śemmanśaḷ kāremuḷḷa manśaḷ,	black turmeric, red turmeric (and) pungent turmeric,
kārāḷam dēśattile veḷanda vara manśaḷ,	the turmeric that is grown in Pānḍia country,[7]
ōṭṭraḍeyām nellu aḍangi varam pōle,	one kind of paddy lasts well,
śembāḷe nellu ange śērandu varam pōle,	*śembāḷe* (kind of) paddy is economical,
kalleyal nellu kalandu varam pōle,	*kalleyal* (kind of) paddy mixes well,
ittane palaśarakku ēṭṭivaram kappal,	the boat brings so many things,
jāti perangāyam śaduroḍone ēti,	good quality asafoetida loaded (into the ship) ably,
pacce karuvapile pāngudane ēti,	green *karuvapile* loaded (into the ship) in style,
āṇōḍu peṇparandēn malyndu keṭṭi pōl,	I (girl) was born with a boy, (and) suffered much,
āgā marandellā koṭṭi vekkyum vēḷe,	the time is such when (even) useless medicines are gathered together,
peṇṇōḍe ēn pirandāi piriyamuḷḷa vidiyē,	why was I born (along) with a girl, of loving fate !
nāgurāry vēnḍiyallō pāttiyā ōdi,	vowed to Nāgur deity (and) offered sugar[8] (to Him),
śandanakaṭṭy mūṭṭi, śāmbarāṇi pōṭṭu,	set fire to sandalwood, (and) put frankincense (in honour of the deity),

1 The fellow was thieving for six months.

2 Mirror is built into the wall in the poorer houses. The boatman before he enters the boat does a lot of mischief in the village.

3 Brother's wife.

4 Husband's elder brother, or, simply, elder.

5 Husband's brother's wife.

6 All these are the cargo.

7 The Pānḍya kindgom is referred to as the *Kārāḷa dēśam* from the legend that the Pānḍya kings had the clouds under their control.

8 Hindus and Muslims alike offer sugar to the Muslim fakirs of the Nāgūr shrine, and the fakir returns it after chanting some prayer. This is called *Pāttiyā ōdi*.

Tamil	*English*
mādāve nambinān maḍivilēyam erangi vandem,	having faith in Mary, I got down into the deep pool (and) returned safe,[1]
mādāvum nijame ānāl kappalam maḍuvum karc śēra vēṇum,	if Mary is true, then the ship will reach the shore,
allāve nambiyallō nānu ārṭilēyam erangi viṭṭe,	I got down into the river believing in Allah,
allāvum ēlēlō nijamānāl, ārugare ēlēlō śērka vēnḍum.	if Allah is true, he must make (me) reach the river-shore.
2. Nālu muttam vāśalile, nānum paḍakkailo	2. When I was sleeping at the door of the house with four courtyards,
pāttu naḍakkāmale pāvam vandu nērndadaḍī,	sin attached itself to me while I walked carelessly,
tinḍikallu mēr kalakke, tingakkalimo śandeile,	the east (and) west of Dinḍigul, on a Monday *shandy*,[2]
kāśikaṭṭu vānga pōne, karunguyile kāṇumaḍi,	I went to buy *kāśi*,[3] I don't see my black cuckoo,[4]
śikkāno kanḍenaḍī, cidambaratte kanḍenaḍī,	I saw Śikkān (name of a person), and I saw Chidambaram,
śukkāne tirupiḍangō, śīrāneerangattaku.	turn the rudder towards Śrīrangam.

LOVE-SONGS OR ĀN PEṆ KĀDAL

The attitude the following songs show towards love and sex is that it is a pleasurable activity, and as such one indulges in it whole-heartedly without regarding it as a sin. The only song (22) which hints at the sin-idea of sex, singularly enough, contains references to Brāhminical mythology.

While sex is pleasure-giving, society chooses to regard certain kinds of sex union as right, and others, wrong. Poem 2 tells us of the elders meeting by the wayside, and finding the girl guilty of transgressing the social sex code.

But the general impression one gets from the songs is that extra- and pre-marital sex union is fairly common, that the sex code is not very rigorous. Poem 14 indicates not only pre-marital sex irregularity, but also the girl raising a loan on her sex. Poem 15 again points to the prevalence of pre-marital sex license, and poem 17, of extra-marital sex license. Finally there is the institution of '*oppiya manam*' (poem 75) by which a man and a girl (whether wife of another, or unmarried) can get away to Singapore, and come back home after a few years with their children to be recognised as man and wife by society. Whether this institution was corollary to the migration of large bodies of Tamil labourers to Singapore, or whether it prevailed even earlier is an open question.

The love songs are sung not only by men but also by women. The reference to the institution of *maḍal ēridal* is highly interesting, and the unique character of the institution makes it a fit object for closer study.

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[1] Near Negapatam, on the Coromandel Coast, all the three religions meet, and this fact is reflected in the song.

[2] Weekly market held on Monday.

[3] Kāśi, *catechu*, chewed along with betel.

[4] His sweetheart is lost in the market crowd

A widow (obviously young) who is very particular about her appearance comes in for some criticism (poem 6).

Time and again, we come across references to the very probable prevalence of free sex relations, even before marriage, between oneself and one's father's sister's son (poems 3, 23 and 25). The attitude towards one's (w.s.) maternal uncle also suggests sex familiarity (poem 8). Poem 28 tells us of the niece who expects to be petted by her maternal uncle. Poem 30 shows us the *maccān* (w.s. sister's husband) snatching the bag from the hand of his wife's sister, while the two were going to a fair. On other evidence, I gather that amongst the "lower" castes a certain amount of dubious familiarity prevails between a man and his wife's sisters.

Tamil — *English*

1. Tannīr kuḍattāvaḷē, en tāgam ellām tīrtavaḷē,
pāvyyaḍi mēle padarudaḍi pon śaraḍu,
tannīr kaḍuttavaḷē, en tāgam ellām tīrtavaḷē,
nān kāṭṭu ellām veṭṭa pōne,
karaḍiyellām vādāḍi,
en uḍumbellā novudaḍi,
minnīr peṇṇē, vennīr vy.

1. (You who have) given me cool water,
(you who have) quenched my thirst,[1]
on the girl's feet spreads the gold chain,
(you who have) given me cool water,
(you who have) quenched my thirst,
I went to cut down all the forest,
I fought with bears,
my whole body is aching,
lightning-like girl, keep hot water (for me).

2. Orutikku orumagaṇḍī,
onne nambi vandavaṇḍī,
porumy poruttavaṇḍī,
kāśukku kaḍalyvāngi,
kālnīṭi tingayile,
mīnda kaḍalykku,
melliyāry tēḍurēṇḍi,
śālykare ōrattile,
śādināyam pēśayile,
kuṭranśu vandudaḍī,
kuyileneyā unmēle.

2. (I am) the only son of a mother,
I came believing in you,
I am a man of patience,
buying gram for money,
I stretched my legs and ate,
for the left-over gram,
I will search for girls (to eat it),
on the edge of the road,
while caste-rules were being discussed,
(you were) touched with defect,
you cuckoo-like girl.[2]

3 Āttukku akkareyile,
attymagaḷ oruti uṇḍu,
nān vāyi viṭṭu pēśayile,
vāḍy paṭṭu śulāyināḷ.

3. On the other bank of the river,
there's my *atty's* daughter,[3]
I spoke out loud (my desire),
the breeze touched her, (and) she became pregnant.[4]

4. Oḍudaḍī, kannātōḷī,
odunguṇdaḍi pāi marangaḷ,
pāi marattu uḷḷāle,
pāmbā śuyalu rēṇḍi.

4. (The boats are) running, O sugar-cane-shouldered one,
the catamaran comes near the shore,
inside the catamaran,
(my mind) twists in agony like a snake.[5]

5. Mūkutti pōṭṭa peṇṇē,
mūnu varān kēṭṭa peṇṇē,

5. O, girl wearing the nose-screw,
O, girl who asked three *varahas*,[6]

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[1] Figurative expression to mean 'you have satisfied my desires.'

[2] This girl sleeps with a boy, either before or after her marriage and the caste tries her and finds her guilty.

[3] Father's sister's or mother-in-law's daughter. Probably used here figuratively, to suggest his desire to sleep with her.

[4] The breeze carries his words to her and she becomes pregnant !

[5] It is a fisherman going in his catamaran away from his beloved. But catamaran hugs the coast, and thus increases his agony.

[6] *Varaha* is roughly equal to Rs. 3-8-0. Obviously, not a "virtuous" woman.

Tamil	*English*
unnu kiṭṭe pēśa vārēn,	I will come to speak with you,
onnu aṇṇan kiṭṭe pēśādaḍī,	do not mention about it to your *aṇṇa*,
mūkile munu muttu,	three pearls on the nose,
muppattāru pacce muttu,	thirty-six green pearls,
adule oru nīla muttu,	in that one blue pearl,
āḷy meratudaḍī.	and (that) does frighten a man.
6. Śalaśalatte murugu kucci,	6. Your *murugu* (ear-ornament) making a *śala śala* noise,
vettalykāra suppany kanḍāl,	if you see the betel-man Subba,
vidattukoru naḍa naḍappāl,	you change your gait every moment,
inda naḍy ēnḍi, vidattuloru naḍy ēnḍi,	why this gait, why this change every moment ?
vālāda pongaḷakku poṭṭu ēnḍi, my ēnḍi.	why should the widow wear the *śānd* mark,
	why should she black her eyes.[1]
	Man speaking :
7. Vēṣṭi veḷattu kaṭṭi,	7. (After) washing the *dhoti* ,white (and) tying it,
veḷḷarambu śungamviṭṭu,	allowing the white-bud *śungam*[2] to hang down,
kūṭṭamā pōgayile,	while (you are) going in a group,
kūppiḍuvēn kaṇṇy kāṭṭi.	I will call you with a wink.
8. Ary kāśikku eṇṇy vāngi,	8. Buying oil for a pie,
anja nāḷ tale mulugi,	and bathing with it for five days,
kūcakāra māmā,	O, you shy *māmā*,[3]
en konḍy toḍalāmā,	(is it right for you) you touch my hair, knot?
nīkudatta kāśu,	the pie you gave me,
en eḍada kālu tūśi.	is like the dirt on my left foot.
9. Veḷḷe śāmandi pūvukkum,	9. For white chrysanthemum flower,
veḷḷāḷe yāvar vēlekkum,	for the Veḷḷāḷa's job,
undane śummā viḍuvēnam ?	will I come wthout (asking you) a question,
onakku sammada paḍavēnō ?	will I consent to marry you?[4]
	Woman :
10. (*a*) Mūnu śilupakkāra,	10. (*a*) (You man) with three *jilpa*,[5]
muruku viṭṭa vīsekkāra,	(you man) with the twirled moustache-
tāyambū vēṣṭikāra,	you with a *dhoti* like a screwpine flower,[6]
tangināl āgādaḍā?	cannot you stop (with me for a while)?
	Man :
(*b*) Vākkapaṭṭu vaḷeyaliṭṭu,	(*b*) (You) having been married (to someone), wearing bangles,

[1] Here is a young widow, who blacks her eyes, wears the *śānd* mark on her forehead, and flirts with someone.

[2] *Śungam*, that portion of the *dhoti*, which, passing between the legs, is tucked in at the waist. Its shape is compared to a bud.

[3] Literally interpreted, it points to the prevalence of free relations between maternal uncle and niece.

[4] Five more songs there are identical with this one, and I have omitted them.

[5] *Jilpa* is the terraced shaving of the head. First there is the long wisp of hair at the crown, the *kudumi* then the hair around it is cut to a height of 1½ to 2 inches, and third, is the shaved head.

[6] The screwpine flower is encased in a cone-like spathe, and probably the trailing *śungum* of the *dhoti* is compared to it.

Tamil	*English*
va*l*ipōkka pōrapennē, vāngina kāśukku oru vaṭṭi mudal illeyaḍi.	you girl going on the road, for the money you have taken from me, I have not received a pie as interest.
	Woman :
(*c*) Māngā pa*l*akaṭṭamē, marattu viṭṭu erangaṭṭamē, tēngā pa*l*akaṭṭamē, tīrta vuḍare ungaḍanē.	(*c*) Let the mango fruits ripen, let them come down from the trees, let the coconut fruits ripen, I will clear your debts, O man.[1]
	Woman :
11. Śandana poṭṭu miṭṭu, śāle mēle pōra śāmi, śandana poṭṭu mēle, nān śanduranda āgādā.	11. Wearing the sandal mark (on the forehead), you man going on the road, on the sandal mark, will you allow me to lean ?
12. Māna marudeyile, māḍa virkum śandeyile, nungu vitta śāna magaḷ, tongurāḷam śālyyile.	12. In Mana Madura,[2] in the market where kine is sold, the Śānār girl selling *nungu*,[3] hangs behind on the road.[4]
13. Karapu puḍavy tirupi kaṭṭi, kaḍe teruve pōra pennē, un kālā*l*i śattam kēṭṭu, kalangudaḍī en manadu.	13. Turning the black sari right about, and then tying it, you girl going on the bazar street, hearing the noise of your toe-rings, my mind is churned up.
	Woman :
14. Karta pyyya tūnḍikāra, karikku ranḍu mīnu tāra,	14. Black boy with the fishing-rod, give me two fish for curry ;
	Man :
śēlekanḍe ranḍu tārēn, śērndu pōgam, vā pennē.	I will give you two *śēlakanḍe* fish, we shall unite, come, girl.
15. Nānum eḷam vyyadu, nīnum eḷam vyyadu, pinjilē kūḍinadu, piriya manam kūḍaleye.	15. When I was young, and when you were young, we copulated when young, now I have no mind to part from you.
16. Puḷḷi ravike pōṭṭu, pudiceriki pōra pennē, en puḷḷi ravike mēḷe, nān vaḷeyu ranḍi.	16. Wearing a spotted bodice, you girl going to Pudicēri, on your spotted bodice, I (my mind) lean towards it.
	Man :
17. (*a*) Iḍi iḍikka maḷe po*l*iya, iranḍu veḷḷam tattaḷikka, koḍe piḍittu nān varuvēn, kuyileneyāḷ tūngādaḍī.	17. (*a*) When it will be raining heavily, when dark floods come noisily, I will come with an umbrella, my cuckoo-like girl, don't sleep.
	Woman :
17. (*b*) Śahanḍe kuḍitta piḷḷy, śakkilikki peṭra piḷḷy, en manadu ottuvara, puruṣam innu tūngaliyē.	17. (*b*) (My husband) who has drunk of my fluid emitted during copulation, he who is born to a cobbler-woman, to do as my mind bids me, my husband has not yet slept.

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1 These three songs form one whole. The two were friends before marriage, and now they are married to different persons. He had lent her some money before marriage and asks for it. She says 'let the fruits in my garden ripen, and then I will pay you back by selling them.' Love has frozen into pride.

2 Town in Ramnad District.

3 *Nungu* is the fruit of the *cadjan* palm, and the Śānārs tap toddy from this plant.

4 She hangs behind to meet her lover.

Tamil	*English*
18. Nilāvum erikaṭṭamē, ninra kaḷe yāraṭṭamē, apparum varumbōdu, nā appō urangavēṇḍi.	18. Let the moonlight shine, I will also take rest, it is time for my father to come home, I will sleep then, my girl.
19. Kūndal myr virittu, kunji myr uḷḷeḍakki, inda kolegāran śīmeyile, konja nāḷām vā*l*aleyo.	19. Spreading out my hair (in the sun), tucking in the *kunji* hair,[1] in this murderous land, I did not live happily even for a few days.[2]
20. Kaḷḷi marattaḍile, kaḷe māṇa ōḍeyile, anda māna piḍikka pōna, kaṇavanē kāṇōmē.	20. Beneath the *kaḷḷi*[3] tree, in the horned-deer-run, to catch that running deer, the husband who went, where is he gone ?
	Man :
21. (*a*) Kuḷḷane kanḍu ā*l*am pārkum, kuṭṭi, kuripppariyā maṭṭi, ō, kuppekāṭṭa kuṭṭi, en kōvam vandu ṭirumbiviṭṭāl konḍu pōvēn neṭṭi.	21. (*a*) You should with caution measure the dwarf's depth, baby,[4] you fool, who does not know the significance of things, O dung-heap baby, if I get angry I will carry you away as (easily) as a cork plant.
	Woman :
(*b*) Aḷ piḍiyan mudale pōl vandāyē, antaramāna pē, aḍakku unran vāi ! āra pa*l*i vānga vandāi, arivi gaṭṭa nāyē !	(*b*) You came like a crocodile trying to get at a man, you devil before me, shut up your mouth! whose life have you come to take away, you senseless dog !
	Man :
22. (*a*) Mōham pollādu mōham pollādu, nāḷukku nāḷu trēham, nelyppudu sandēham viḍāwal, anubōgam śeyyalām vāḍi, mōham pollādu.	22. (*a*) Love is bad, love is bad,[5] day by day the body, its continuance is doubtful, without leaving let us enjoy, come, love is bad.
	Woman :
(*b*) Pāvam pollādu, pāvam pollādu, pāvam mēḷukku mēlāi, śāvam perum mūṭṭegaḷāham, enbady iniyānu viḍu torettēn, pāvam pollādu.	(*b*) Sin is bad, sin is bad,[6] if sin comes upon sin, the curse will be a big bag, that I have told you already, sin is bad, etc.
	Man :
(*c*) Āle karumbenavillā, kaṇe toḍuppadāle, āhayāl immēle kāma, kōkkōha līle śeyyalām vāḍi, mōham pollādu.	(*c*) From the bow of the sugarcane that goes to the crushing machine, the arrow is being aimed at me, therefore from now on, (we shall), play according to the *kōkkōham*,[7] come, etc.

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1 The small curling hair on the temples is considered a sign of beauty, and care is taken to display it properly.

2 She loses her husband as soon as she enters his house, and so she blames the entire country which she has so recently entered.

3 *Euphorbia tirukalli.* Probably said by Sītā when Rāma went in search of the *rāksasa* disguised as deer.

4 A dwarf is suspected to be a deep fellow.

5 Used to mean that it is too powerful to be restrained.

6 The man is inviting the girl to bed with all the persuasiveness of an old, clever lady-killer. The girl, on the contrary, is young, innocent, and fears sin.

7 Reference to *Kōk Śāstra*, the 'science' of erotics.

Tamil	*English*
	Woman :
(*d*) Dēvaraḷ mukkālatil,	(*d*) The *dēvatas* in the days gone by,[1]
mādavariḍal śenrum,	went to (god) Mādava,
kādal adikagonḍu pādagattilānārgal,	the *dēvas* became sinful through excess of love,
tānum adu pōlāvāi, pāvam pollādu, etc.	O man, you will also become like that, love is bad, etc.
	Man :
(*e*) Māran viḍuganē pāyidu nāmayily,	(*e*) The arrow which Māra[2] shoots, pierces my heart, O my peahen,
edur vandenny tāviḍamārā !	Māra comes, and falls directly on me.
	Woman :
śōran veḷyppadāgādu nīnirmōda,	To have thieving pleasure is not becoming, O fool,
śolluvēn kēḷaḍa !	I will tell you, man.
	Man :
(*f*) Irāru mangeyir pādam paṉin-daṭṭēn,	(*f*) I fell at the feet of twelve women (and) saluted them,
nēriṭṭu ingenna ēriṭṭu pārāḍi,	you look at me, directly.
	Woman :
pāril damayanti mīdal kādal gonḍu,	On this earth, having desire towards Damayanti,
paṭṭanru vēḍan tiṭṭandu erindān.	the vēdan (hunter) was burnt in a trice.
	Man :
23. Kaṉṉe, muttan tādi,	23. My eye, give me a kiss,
kaṭṭalagi lēḍiyē,	beautiful lady,[3]
ennuḍan kuḍiyē !	become one with me.
	Woman :
Kaṉṉe enru śolluvudu,	To call me, eye,
nallaḍalle, pollādaḍā,	is not good, it is bad,
nān śonnēne, kaṉṉā nī en mun nıllāde	I told you, Kaṉṉa, don't stand before me.
	Man :
Pūtta malar mette inmēle,	On a pillow of blossomed flowers,
pōhalān iru ormāi,	let us go there to unite,
aḍi, ponnē, nān innēram śonn-ayinē !	you girl, I have told you so long !
	Woman :
Metteyanḍe pōguvum nī,	To go to the pillow,
attemaganō śolluḍā, mannā nī,	you king, tell me whether you are my father's sister's son,
mannā, nī kannavan, en mun nillāde.	you king, coppersmith, don't stand before me.
	Man :
Nāgarika mānatoru nangeyē,	You civilized lady,
nī kūḍavāḍī, nānē śonnēne,	come to unite with me, I (have) told you,
ninrēne en mīde kaṉṉe muttan tāḍi.	I stand before you, my eye, give me a kiss.
24. Āla mara murangē,	24. When the banyan sleeps,
aḍi maratta vanḍu ranga,	when the bee sleeps,
unmaḍi mēle nān uranga,	when I sleep on your lap,

[1] Probably this is a reference to the legend that in the *trēta yuga*, the *riṣis* fell in love with *Rāma*, and for that sin they were born as *gopika strī* in the *dvāpara yuga*.

[2] Māra is one of the names of Manmatha.

[3] The word 'lady' is used in the Tamil version itself. This song is clearly a very recent composition.

Tamil	*English*
en tangamē, tillāle, manamirundāl,	my gold, *tillāla*, if you like me,
pōdumaḍī en ponnum tillāle.	it is enough my gold, *tillāla*.
25. Nāgarattinamē, en nāṭṭu śakkarayē,	25. My cobra-gem, my country-sugar,
jīvarattinamē, en śīni śakkareyē,	my life-gem, my sand-like sugar,
nān paḍuttiḍa, nīn muluttiḍa,	while I am asleep, (and) you awake (by my side),
nāi polattiḍa, pāi pōṭṭiḍa jīvarattinamē !	and the dog barking, the mat being spread, my life-gem !
	Woman :
Urimy yaṭravanē,	You who have no right,
śeṭṭru unarva keṭṭavanē,	you bad, senseless fellow,
nī oru manidā uny yaḍayavā,	is it possible for me to go to bed with you,
perumy yaḍyyava, pōguvāi nīyē !	to save your honour, clear out.
	Man :
Attemagan nānallavō, en pattini pennē,	Am I not your father's sister's son, my chaste girl,[1]
aśe yāyi vandenaḍī, mōśam śeyyāde,	I came with desire, don't deceive me,
on jālamellām ennaḍam palikkādaḍi.	your tricks won't do with me.
	Woman :
Śinna śerikka enru enna ēmāṭrādeḍa,	Don't try to deceive me as I am a young girl,
kannattil aryvēne, vannāra pylē !	I will slap you, you washerman boy.
	Man:
Mangaḷamāi undaneyē,	Auspiciously, with you,
Singapur konḍupōi,	taking you to Singapore,
oppiya manam muḍikka mānē,	we shall perform *oppiya manam*,[2]
unny kappalakku ēṭruvanḍi, tēnē.	I will make you get up the ship.
26. Paṭṭu paṭṭāḍe tārē, paṭṭanattil pādi tārē,	26. I will give you a silk sari, I will give you half the town,
pāveyare ennaḍattil śīr, śīr,	woman, enjoy with me, enjoy.
	Woman :
Paṭṭu paṭṭāde vēnḍa, paṭṭanattil pādi vēnḍa,	I don't want a silk sari, I don't want half the town,
pangam gaṭṭa maṭṭi appāl nil, nil.	honourless fool, stand aside.
	Man :
27. (*a*) Kaṭṭāni mutte, pennē,	27. (*a*) O, good pearl, girl,
karunguyile unnāle,	black cuckoo, (because of) you,
kaṭṭāyam kappalēri,	I will certainly get up a ship,
vakkapōrēn śavvāri, vakkapōrēn śavvāri.	I will go away riding on a horse, etc.[3]

1 *Pattini* is the word actually used here.

2 *Oppiya manam*, a form of elopement prevalent among the Paryyans. A man, and an unmarried girl, or another's wife, elope to Singapore, stay there for a few years, and return home with their children. They are then recognised as man and wife.

3 The expression used here is *vakkapōrēn śavvāri* which literally means 'I will ride on a horse,' and in this context means, 'I am going away.' The idiom above refers to an ancient Tamil institution called *Madal ēridal* (mentioned in the Tōlkkāpiyam and the Tiruvāmuli). When a man was refused by a girl, he threatened to ride naked a horse made of palmyra leaves and the stem of the same plant. The cutting edge of the leaves would saw through the thighs of the "horseman," and if a white liquid (confounded with semen) flowed from the sinews, it was supposed to be a case of genuine love, and the villagers would bring about the marriage, irrespective of the wishes of anyone but the man.

Tamil	*English*
(*b*) Oṭṭārakāri unnypōlē, unny pōle ulakaṭṭile, aruvareyim kanḍadileyē, unukku manam valleyē, unukku manam valleyē.	(*b*) You self-willed girl, like you, another in the world, I have not seen anyone, your mind did not turn towards me, etc.
(*c*) Madiyāmal neneyavadālo, mēlōre icce vyttāl, māluvāi nīyam śandiyil, nenekkurāi un pondiyil, nenekkurāi un pondiyil.	(*c*) Without caring for me, if you desire for a higher caste man, you will die at the place where roads meet,[1] if you think you can copulate with a higher caste man.
28. (*a*) Kanji kondu vandēnayyā, kādaḍappe tīrka vēnḍum, konji vilyyāḍiḍuvōm, endan māmāvē, kuḍi vilyyāḍiḍuvōm, enśendamāmāvē.	28. (*a*) I have brought *kanji*, I have come to satisfy your hunger (which has caused deafness), I will play like a child, with my *māma* (maternal uncle),[2] we will play together, with my own *māma*.
(*b*) Paccarasi kutti, pakkuvamāi śōrā-ākki, payir uḍytta tuvayaluḍum, endan māmāvē, pakkuvamāi konḍuvandēn, endan māmāvē.	(*b*) Pounding new paddy, (and) cooking the rice well, (and) making chutney out of green gram, my *māma*, cooked well, I bring them to you, my *māma*.
29. Anji kiṉṉattaṉṉīr, araṅgaṉattu nalla taṉṉīr, uppu karikir taṉṉīr, udavādu, akkā māmamakku.	29. Cool water of five wells, cool water of rare well, water for the salt-fish curry, it won't do, (for) *akka* (elder sister), *māma*,[3]
30. (*a*) Nāgūraḍī, maṉavaraḍī, tirukkōyilur tēraḍī, tirukkōpuratte pāraḍī, ayyō maccān, kaiyē viḍu, śygyyile pyyi pōḍu.	30. (*a*) In Nāgūr, my girl, at Maṉavar,[4] the juggernaut of Tirukkōyilūr, my girl, look at the temple tower, my girl. O, *maccān*, drop my hand,[5] give back my bag(?).
(*b*) Śavattu kuṭṭi śingi, un śēlyyellām vangi, nī śakkacci vanda peṉṉē, enukku pakkuvamāi kaṉṉe.	(*b*) Red girl Śingi, your sari is all folds,[6] you are a fair girl, you are ripe for me, my eye.
(*c*) Aḍutta vīṭu alamēlakka, kaḷakennu śirittāl, aval kaḍakkurāl pytyakāri,	(*c*) Next house Alamēlakka, she laughs, *kaḷak*,[7] she lies there, mad woman,

In the case of a girl, a mere threat by her to 'ride the horse' was enough to force the hands of whosoever that did object to the wedding.

1 Probably, he threatens to hack her, and strew the members at the crossing of roads.

2 *Konji*, the term used here means behave like a child. Said of a grown up boy who behaves like a baby before his overfond parents. Probably, the privilege of behaving like this with one's (w.s.) maternal uncle was a recognised institution.

3 Probably the *akka* has married the *māma*. Marrying one's elder sister's daughter is common.

4 Manavar is a place in Negapatam.

5 The *maccā* (w. s. wife's brother and sister's husband) is taking her to a fair, and in play, snatches her bag.

6 Probably said in appreciation of the spruce way in which the folds are arranged.

7 The neighbour who is also at the fair laughs at the *maccān* snatching his brother's wife's (or wife's sister's)bag. Her sudden sharp laughter is described thus.

Tamil	*English*
avalakettine vydyakārar,	how many doctors for her ![1]
śirikkudaḍi śandy, on śēlyyellām kande.	the whole fair laughs at you (Alamēlakka), your sari is all tatters.
(*d*) Kālayile e*l*andu, kālgāpu tīrtum gonḍu,	(*d*) Getting up in the morn, losing the anklet,
śālyyile pōgumbōdu, māly vāsam manakkudaḍī,	while going along the road, your flower garland exudes a smell,
ingida kuyil māne, en sangīda kuyil tēnē.	my sweet cuckoo, deer, my musical cuckoo, honey,
nāgurārē vēnḍuvēn !	I beg the deity of Nagore.[2]
31. Tilly cidambaramām, śella piḷḷy śettiramām,	31. In Sellapiḷḷy's hospice in Chidambaram,
śellapiḷḷy śattirattil nām śarappāga vandōmaḍī,	in great style we reached Sellapiḷḷy's hospice,
śingāra vanḍiyēri, śiruḍane vandirangi,	in a beautiful cart, we travelled like respectable folk,
pārkura janangaḷellā pāva menru śolluraral,	the people who saw (us), they say it is sinful,
kūḍi irundōmaḍī, kommāḷam pōṭṭu maḍī,	we lived together, we had a jolly time,
vā*l*e pa*l*am tinna iḍam, pā*l*ā kaḍakkudaḍī.	the place where we ate plantains, looks deserted (now).
32. Nānaḍittēn tanti,	32. I struck the wires,[3]
tantimaram vīndu pōcu,	the telegraph pole fell,
janangaḷakku terandupōccu,	the people came to know of it,
nī pōḍi ottā vīṭṭe śinna tangamē,	you go to your mother's house, my small Tanga,
nān pōrēn rangūnukku.	I go to Rangoon.

Ētta Pāṭṭu

Large tracts of South India are irrigated by wells. The water is pumped out of a well onto a number of small channels which criss-cross the fields. A perpendicular pole (usually of the palmyra tree) is crossed at the top by a horizontal one in the form of a T. To one end of the horizontal pole is suspended, from a cane, or from stout coir, a huge leather receptacle (*śālu*). Footholds are cut into the horizontal pole, and a man moves on it to see that the two arms of the T move up and down like a see-saw to take water from the well and empty it along the channels. A man below looks to the emptying of the tub. Often there are three men on the job.

The work is very tedious, and would probably be unbearable but for the singing which accompanies it. And the singing includes counting—rather, the dry task of counting how many tubs of water are emptied into

[1] Probably means, 'how many doctors do you need at your pregnancies ?'

[2] The whole song describes a fair held in Nagore in Negapatam.

[3] Probably when drunk, he fells a telegraph pole, and to escape punishment, he goes to Burma as a labourer.

the fields, is woven into the songs; so that at the end of the song the ryots know how many tubs are emptied into the fields.

The song is a kind of a running commentary. The ryot sings of whatever catches his eye or ear. Frequently, he sacrifices sense for sound. But, in spite of it all, the *ĕtta pāṭṭu* gives us, like all folk-songs, an insight into the ryot's mental make-up.

The singers pray for the safety of the man moving on the upper arm (*alagam*) of the T—it is a risky job, as he works nearly ten feet above the ground—for preventing the tub-rope from snapping, for keeping the nail (*konḍāṇi*) with which one pole is fixed to another from coming off, etc.—They also vow to present Valli (Lakṣmi) with a silver sling with bell-metal stones to hurl at the birds that come to eat up the crops. In fact, religion is seen to have a utility in the day-to-day earthly job of securing a livelihood. The deities guarantee us food, and guard us from dangers.

Incidentally, one is strongly made aware of the element of truth in Functionalism.

The deity worshipped most in the *Ētta Pāṭṭu* is Piḷḷyyār or Gaṇēśa. This may point to a deep relation between Gaṇēśa and the welfare of the crops before (?) his elevation to the status of a major deity in the Hindu Pantheon.

Vēlā or Subrahmaṇya, the great Dravidian deity, is also prayed to, and addressed as 'Vēlā of the edge of the paddyflat.' The importance of Subrahmaṇya is, however, general, and not specific. He dominates the religious consciousness of the Tamilian.

There is a reference to the Tamilian practice of offering deities parts of the body made in gold, silver, etc., in satisfaction of vows taken. The sanctity of offering is emphasised by a reference to tying a cloth across one's mouth while cooking the dish to be offered to the deity.

Non-religious matters also crop in, like trapping a deer, the description of the acrobatic Domba, and the reference to the magic of Malabar. The existence of a foreigners' (Greek, Roman or Arab) settlement on the Coromandel Coast is mentioned, and the description of the foreigners is certainly not flattering to the latter. (Three dots occurring indicate a gap caused by omitting the numbers counted).

Tamil	*English*
1. Uḷḷam kadirōne, piḷḷyyāre vārum piḷḷy perumāḷe,	1. Sun who is in the heart, come, O Pillyyār Piḷḷy God,
nalla piḷḷyyāre, nānenna paḍyappēn?	good Piḷḷyyār, what shall I offer you ?
paccaraśi tēngāi, payaru palagāram, paḍyppēn piḷḷyyārku,	fresh rice, coconut, gram offering, will I offer Piḷḷyyār.
piḷyyal vandadāna payigal vanḍu nērum,	if mistakes come, sins come in their wake,
payivarāmal kāttāl paccaraśi tēngāi,	if (you Piḷḷyyār) guard me from sins, fresh rice, coconut,
payiru padinkala, eḷḷukalandadu,	ten *kulams* of green gram mixed with gingelly,

Tamil	*English*
ēlu kala ariśi, payaru kalandadu,	seven *kalams* of rice with green gram mixed,
padinkala ariśi, āny aḍi pōle,	ten *kalams*[1] of rice (as big)as elephant's foot-print,
adirasangaḷ nūru, āny aḍi pōle,	hundred *atirasas* like elephant's foot-print,
ōṭṭaḍeyā nūru, ōṭṭe aḍi pōle,	hundred *ōtrades*,[2] like camel's footprint,
palagārangal nūru, panni mugam pōle,	hundred offerings like pig's face,
porivaḷangāi nūru, puny aḍi pōle,	hundred puḷḷangāi balls[3] like cat's face,
māpiḍiyā nūru, māṭṭaḍi pōle,	hundred sweet balls like cow's footprint,
ko*l*akaṭṭe nūru, kudure mugam pōle,	hundred *kolikattes*[4] like horse's face,
veḷḷarikka nūru, vērule pa*l*kum,	hundred cucumbers (which) ripen on the root (alone),
kattarikka nūru, kāmbaḷe pa*l*kum,	hundred bringals (which) ripen on the stalk,
mānganiya nūru, marattile pa*l*kum,	hundred mangoes (which) ripen on the tree,
kulyyiḍane tēngāi, kottuḍane māngāi,	bunches of coconuts, bunches of mangoes,
konḍu vayippēn vēlā,	I will bring, O *Vēlā*,[5]
uyarndadodu śakku, ūrukku vaḍakke,	a sacred oil presser, to the town's north,
śakkale koṭṭi, śengannugaḷe ōṭṭi,	pour (all the above) into the presser, (and) drive the red bullocks (of the press),
vala yiḍame pūṭṭi, mūnu śuttā ōṭṭi,	tie them to the right (and) drive them round thrice,
motteyā teraṭi,	make a round ball (of the mixture),
vaḍakka maly ēri, vā*l*y ele arindu,	climb the northern hill, cut off a plantain leaf,
tekku maly ēri, tēkkile pariccu,	climb the southern hill, cut off a teak leaf,
oḷeleyā pōṭṭu, īkkuḍan piḷandu,	spread seven leaves (and) sew them with broomstick,[6]
ilygaḷē arindu, ōḍu mutti tēngāi,	cut the leaves (and take) shell-ripe coconut,[7]
oḍipēn piḷḷyyāre, nīrumutti tēngāi,	I will break coconuts with ripe water inside, Piḷḷyyar,
nivētya mudalāi, pālu muttina tēngāi,	I will offer ripe coconuts,

[1] Atirasa, a sweet cake prepared with rice-flour and jaggery, and fried in oil or ghee.

[2] A salted cake prepared with rice flour, and baked in a pot.

[3] Sweet balls prepared with green gram and jaggery.

[4] A common Tamil dish of which Piḷḷyyār is supposed to be very fond. It is segment shaped, with a thin outer skin of rice flour, and inner stuffing of jaggery and grated coconut.

[5] Subrahmaṇya as Vēlāyudhan, the weapon with which he killed Śūrapadma. The offering is to Piḷḷyyār, but Vēlā is also refrerred to.

[6] Seven coconut leaves, midrib removed, and sewn together with broomstick, make the dining leaf of the poor.

[7] In another version of the *ētta pāṭṭu* I find two other offerings to Piḷḷyyār mentioned: 'The milk from the right breast of a young girl who is living apart, from her husband (prostitute's?), and the milk of a she-buffalo which has not yet calved. The actual lines are:

'Vā*l*āda kumāri valada moly pāl,
ināda kiḍēri iḍadu moly pāl.'

Tamil	*English*
paḍyppēn piḷḷyyāro !	(I will) offer you, Piḷḷyyār !
vaigaṭṭi paḍyppēn vandumudu koḷḷum,	I will offer with tied mouth,[1] come, you take food,
ēttagary vēlā, elndamudu uṇṇum,	*Vēlā* of the ridge of the paddyfield, get up to eat the ambrosia-like food,
āṭrugareyōne aḷḷiyamnduṇṇum,	O, (*Vēlā*) of the river-bank, take and eat the ambrosia,
accimuriyāḍe, alagam piraḷāde,	if the axle does not break, if the *alagam*[2] does not roll over,
kōlu oḍiyāde konḍāṇe tuḷḷāde,	if the stick[3] does not break, if the *konḍāṇe*[4] does not snap,
śālu neriyāde, śālvaḍamarāde,	if the *śālu*[5] does not break, if the tub-rope does not snap,
pādam peralāde, paḍi śerakkāde,	if my foot does not roll over, if my step does not miss,
mūvareyam kāttu, munnaḍakka vēn-ḍum,,	if you protect us three, please lead us ahead,
munne naḍandīrānāl kannaḍaka pon-ṇum,	if you lead us ahead, (we give) you gold eyelid,[6]
kykku vaḷḷi kāppum, mārukku ni-renda,	silver wristlets, for the chest,
māṇikka padakkam, tōḷukku nirenda,	coral necklace, for the arm,
tulasi maṇi maly, kykku nirenda,	garland of *tulasi* beads,[7] for the hands,
kangaṇam ponnāl, kālukku nirenda,	gold *kangaṇam*, for the ankles,
kanḍasaram ponnāl, śāṭṭu tirunāmam,	gold chain, (wearing) sacred *nāmams*,
pōṭṭum pulitōlum, rāmar vanampārka,	(and) tiger-skin, to see Rama's jungle,
iranḍuḍane vārīr. . . .	come with these people. . . .[8]
eṭṭuḍane vārīr ēṭṭi malar konny,	come with 8 people, bunch of *eṭṭi*[9] flowers
īśanārku māly, pacce māly konny,	garland for Śiva, garland of green leaves,
paramaśivan māḷy, pārvatiyammāle,	garland for Paramaśiva, Pārvatiammāḷ,
parvatiyammāḷe, pakkam vandum kārum,	O, Pārvatiammāḷ, come to our side, (and) protect us,
kāttaruḷavēṇum kanakāmbikeyē vārum,	we want your kindness, protection, come, Kanakāmbike,
śīdy śarymīṭka rāmar vanam pōnār,	to release Sīta, Rāma went to jungle,[10]
śīty in anumān śēdi terindānām,	Hanumān got the news from Sīta,
eṇṇum padinār iruvadiyāl onnu, . . .	count sixteen, one and twenty, . . .
iruvediyālāru, irupuram valli,	six and twenty, both sides silver,
tine vanamum kāttāḷ, vaḷḷikku vēnḍu,	(Lakṣmi) guarded our grain-fields, vow to give her,

1 When the devotees are very particular, a cloth is tied across the mouth while preparing and offering food. This is to prevent contamination of the food offered.

2 The upper horizontal bar of the *ēta*.

3 The stick with which the water-bag is tied to the upper stick.

4 Long nail fixing the horizontal bar to the perpendicular.

5 *Śālu* is the water-bag.

6 It is very common to offer parts of the body in silver or gold to deities. Thus a man offers a silver leg to a deity if he is cured (say) of eczema on it.

7 Beads are made of the stem of the tulasi (*ocimum sanctum*), and worn by the orthodox.

8 The three dots in succession indicate the omission of the counting which follows.

9 A plant with very fragrant flavours, and bitter, poisonous fruits.

10 Wrong mythology.

Tamil	*English*
valliyāl kavandu, vengalattāl undy,	silver sling with bell-metal stones,[1]
undy pōna dūram, uruvareyum kānum,	nobody knows the distance the bird travelled,
kallupōna dūram, karnan varakkānum,	the distance the stone went, I did not see Karnan coming,
villupōna dūram, vīman varakkānum,	the distance the bow went, I do not see Bhīma coming,
murugary nān pāda muppōdiyāl onru, . . .	I sing the praise of Muruga, one and thirty, . . .
muppōdiyālāru, āroru puramām,	six and thirty, a town by the river,
mēyudu kilymān, kāttoru puramām,	the horned deer grazes, a town by the forest,
kattudāvalyyai, kattina valekki,	spread the net, and to the spread net,
pattudu kily mān, śēndina valekki, nārāyana rāma,	the horned deer fell to the spread net, Nārāyana, Rāma,
nārpadiyāl onru . . .	one and forty . . .
nārpadiyāl āru, nāradan perakka,	six and forty, when Nārada was born,
bāradam nadekka, kannagi perakka,	when the *Bhārata* war went on, when Kannagi was born,[2]
gana madure aliya, śīteyum perakka,	when great Madura was burnt, when Sīta was born,
tenni lange aliya, āndavane vārum,	when southern Lanka was burnt, come, on, god,
inbadiyāl onru . . .	one and fifty . . . .
inbadiyāl āru, ambupōna dūram,	six and fifty, the distance which the arrow went,
arjunane kānum ;	I don't see Arjuna ;
villu pōna dūram, vīman varakkānum	the distance which the bow travelled, I don't seem Bhīma coming,
kallu pōna dūram, karnan varakkānum,	the distance which the stone travelled, I don't see Karnan coming,
vīmane yai kandu vemburāle valli,	seeing Bhīma, the lady suffers (with unsatisfied sex),
karnany kandu katturāle valli,	seeing Karnan, the lady shouts (with desire),
arjunany kandu alugurāle valli,	seeing Arjuna, the lady weeps (with desire),
āra ragurāma, arupatiyālonru, . . .	six Rāma, one and sixty, ...
ātte kanda pārpān, alara muluguvāne,	the Brāhmin who sees a river, dips well in it,
śōtty kanda kāgam suyalapparavādē,	the crow which has seen rice, won't fly away,
kōli kanda kīri kuru muli kollādō,	the mongoose which sees the hen, looks askance at it,
ēla ragurāma eyabadiyāl onru, . . .	seven, Rāma, one and seventy, . . .
eyabadiyāl āru,	six and seventy,
eleyavale vādī, malyyālam pōvu,	come young girl, we will go to Malabar,
malyyālattu vitty, teriyamada śidda,	Malabar's ways, Śidda, do you know ?

1 The ryots have a sling with a three-thread contrivance in the middle of it to keep the stones in. The sling is whirled round and let loose at the birds that come to eat up the crop.

2 Kannagi is the heroine of the Tamil Classic, Śilappadikāran, and she was responsible for the burning of the Pāndyan capital of Madura.

Tamil	*English*
maleyāḷattu peṇgaḷ mayu vittyakāri,	Malabar girls are all magicians,
śōnava teruvil pōnavan tirumbān,	the man who goes to the *Sōnaga*[1] street, is not likely to return,
śōnava śerikku śukku vittykāri,	the *Sōnaga* girls are very deceptive,
ennum padināru, enbadiyāl onru, . . .	count sixteen, one and eighty, . . .
enbadiyāl āru,	six and eighty,
enda maly kombu, enbadaḍi, kambam,	of which hill is this a horn, this eighty foot pillar ?
eḍutta naṭṭār tomban, kambatta mēlēra,	the Dombas[2] planted it upright, to climb it up,
tomba peṇgaḷ vārārgaḷ,	Domba girls will come.
tōrṭṭinaḷḍā rāma, toṇṇūriḍal onru, . . .	she came on the scene, Rāma, one and ninety, . . .
toṇṇuraḍi kambam,	ninety foot pillar,
tūkki naṭṭān tomban, enbadaḍi kambam,	the Domba lifted it up and planted it, the eighty-foot pillar,
eḍuttu naṭṭān tomban, kambattil mēlēre,	he took it and planted it, to climb it up,
kambattil mēlēre, tombaccigaḷ vārārgaḷ,	to climb the pillar, the Domba girls will come,
maravan kāśināda, narasingavatāra,	Maravas,[3] Lord of Kāśi, Narasimha *avatār*,
mīnar uḍal onru, . . .	one and hundred. . . . .
myyatile śaṇḍe, marupiḍadu kappal,	fight at the centre, and then (catch the ship),
mūnda nāḷe śaṇḍe, vandavākiṭṭe,	day before yesterday, fight at Wāndiwash,[4]
nālānāḷe śaṇḍe, vandavākiṭṭe,	four days back, near Wandiwash,
indanāḷy śaṇḍy, āraṇi velūr.	five days back, at[1] Āṛṇi (and) Vēlūr,
vāl malaga śukku, vārivaram kappal,	long pepper,[5] ginger, the ship wli bring,
ēlaraśi śukku, ēṭṭivaram kappal,	cardamom, ginger, the ship will bring,
kiccili maḷagu koṇḍuvaram kappal.	oranges, pepper, it will bring.

Humorous Songs

The Fish Curry Song

Tamil	*English*
Nānum āttaḷam nārattān kuṭṭyyil nanḍu taḍavinō,	Myself and mother[6] searched for crabs in the *nārattān* pond,

1 According to the Tamil Lexicon, Śōnaga means a foreigner, especially a Greek, Arab or Moor. The passage in the song comments on the existence of a 'foreign' settlement in South India. And these fellows were 'murderous,' and their women-folk, 'deceptive.'

2 Domba, an acrobat, nomadic caste of South India. The women-folk are pedlars selling needles. Their sex regulations are notoriously lax. The men are expert at catching foxes which they eat.

3 Caste of Maravans.

4 Historic scene of battle ; Āṛṇi and Vēlūr were also battlefields.

5 Usedl aong with betel leaves.

6 Āttāḷ, means mother. But it is also used to denote any female member in the family like the grandmother, sister, mother or daughter.

Tamil	*English*
nākattām pāmbu ṅākky valyttadu,	the *nākattām*[1] worm bent its tongue,
tumbu kilale śuyaṭṭi aḍittadu,	I lifted it by getting it to twirl round a twig,
āttāḍi ammā pāmbaḍī,	O, mother, it's a snake,
illēḍi magaḷē vilāngaḍī,	no, daughter, it is a *vilāng* (kind of fish),
eḍuttu karryyilē pōḍaḍī,	remove it, and throw it on the shore,
kalayil eḍutta vyyaḍī,	put it into the pot,
kallilē vyttu urayaḍi,	put it on a stone and rub (away its scales),
kattīle iṭṭu ariyaḍī,	cut it with a knife,
arinda mīny alyśśaḍī,	clean the cut fish in water,
arinda mīny kaṉuku pātēn,	I counted the cut bits,
arubadu kanḍaṁ śariyāci,	there were sixty bits all right,
ammīle arytta śāmān vyttu,	kept the soup-ingredients in the (mortar to grind them to a paste),
aḍuppil vyttu kodiki vyttēn,	I kept it on the stove (and) boiled it,
taṉṉīku pōgyyil koncam tinnēn,	I ate a little (of the fish) when going to fetch water,
ulyyai vakkimbōdu onnu tinnen,	I ate one bit while keeping the stove,
upkāra tirkumbodu pattu tinnēn,	I ate ten bits while adding salt, chillies,
aḍupu erakkimbōdu anju tinnēn,	I ate five bits while the stove-fire was burning,
ninrukkum bōdu nālu tinnēn,	I ate four while standing,
pēśikiṭṭa irkambōdu padinanjutinnēn,	I ate fifteen while talking,
ariśi pōḍumbōdu anju tinnēn,	I ate five while putting rice into the vessel,
śādam vaḍikkimbōdu pattu tinnēn,	I ate ten while filtering the boiled rice,
śakkaḷatti pūny vandu ammā,	the *śakkaḷatti*[2] cat came, mother,
jāḍe mīneyum tinruviṭṭudu.	and ate away all the fish.

The Toddy Shop Song

Kaḷḷu kaḍyyē enny kāpāṭrum,	O, toddy shop, you should protect me,
karikkaḍyyē, iḍli kaḍyyē enny iḍēṭram,	O, mutton shop, O, *idli* shop,[3] you should save me,
kaḷḷu kaḍy pōgamāṭēn, veḷḷy taṉṉīr ṅān kuḍippēn,	I won't go to the toddy shop, I will drink white water,
nān kuḍuttadu ranḍu aṉā kāśu,	I gave two anna worth of pies,
nīn kuḍattadu oru puṭṭi kaḷḷu,	you gave me one bottle of toddy,
kaḷḷy kaṉakkā pōḍayya, ōyi pōḍayya,	measure out the toddy properly, O, Nāḍār man,[4]
nāḍāryyyā, kaḷḷy kaṉakkā pōḍayya,	Nāḍār man, measure out the toddy properly,
kaḷḷu sugamā illy, karividu jōrā irkudu,	the toddy is not good, the mutton curry is hot,
pinnum oru puṭṭi pōḍayya, ōyi nāḍārayya,	O, Nāḍār man, pour out another bottle (of toddy),
andi śandi ranḍu vēḷy,	both in the morning and evening,

[1] A snake-like worm which the daughter mistakes for a snake.

[2] *Śakkaḷatti* means a co-wife, but it is also used as a term of abuse. The daughter tells the mother that the wretched cat ate away the whole lot.

[3] Every toddy shop has attached to it a number of parasite shops selling spicy and pungent tit-bits to the drunkards.

[4] Śānār, the toddy-tapper of the Tinnevelly district.

Tamil	*English*
ondi ondi maramērum,	you climb the tree, pressing yourself against it,
tondi karytta nāḍāre, ōyi,	O, black-bellied Nāḍār,
kaḷḷy kaṉakkā pōḍayya,	measure out the toddy properly,
kōṉa maramērum, kuḍu kyl kaḷ ȧrakkam,	climb the curved tree, carry the toddy down in the gourd,
tondi karappa nāḍāre, kaḷḷy kaṉakkā pōḍayya.	black-bellied Nāḍār, measure out toddy properly.

The Pailwan

Enny pōl pailwān, ī ulakattil kaḍeyādu,	There is no *pailwān* (wrestler) like me in this world,
pattu varuśamā kattu konḍēn oru kuttu śanḍe,	for ten years I learnt a kind of fisticuffs,
śattadoru pāmbe kanḍāl eṭṭu kādam ōḍiḍuvēn,	if I see a dead snake, I will run for eight miles,
nān kālillāda muḍuvanoḍu,	with a lame man,
kanḍippāi śanḍy śyvēn,	I will certainly fight,
kaṉṉillāda kuruḍanoḍu,	a blind man,
kāl tuki udikke pōve,	I will certainly kick him,
enny yārāvudu kanḍu viṭṭāl,	if any one sees me (doing this),
ippaḍiyē ōḍiḍuvēn.	I will run immediately.

Humorous Song

1. Erenḍāṭṭuku eṭṭu kālu, māmāḍāmāmā ōyi śanda māmā,	1. Two goats have eight legs, O, *māmā*, my own *māmā*,[1]
ōyi śāpaṭrama, en peṉ jātiye kēṭṭu, pāraḍā,	O glutton, (if you like) ask my wife (whether it is true or not),
kuṭṭi śavattil kurāḷu mēyudu, māmā, etc.,	near the dwarf-wall the she-goat grazes *māmā*, etc.,
nān eṭṭi pārtēn kuṭṭipōḍudu, oyi, etc.,	I peeped in to see it deliver (a kid), *ōyi*, etc.,
ēri niraya taṉṉīr kaḍandāl, māmā, etc.,	if the tank is brimful with water, *māmā*, etc.,
nān kareya mēle pōyi kary mēl, varevēn, oyi, etc.,	I will walk on the bank and return, *ōyi*, etc.,
ēri taṉṉīr vaṭṭi kaḍandāl, māmā, etc.,	if the tank is dry of water, *māmā*, etc.,
nān vaḷeya vaḷeya mai nīndi varevēn, oyi, etc.,	I will go aswimming in it, *ōyi*, etc.,
nān śattā polakka māṭēn, māmā, etc.,	if I die, I won't survive, *māmā*, etc.,
en śittappanē kēṭṭu pāraḍā, ōyi, etc.,	ask my *śittappa*[2] (if you want to), *ōyi*, etc.,
śatta mūḍina kaṉṉe terekamāṭṭēn, māmā, etc.,	if I die, I won't open my eyes, *māmā*, etc.,
nīṭṭina kāly muḍaka māṭy, ōyi, etc.,	I won't bend the stretched legs, *ōyi*, etc.,
ārkāṭṭil śanḍyyānāl, māmā, etc.,	if there is a fight on at Arcot, *māmā*, etc.,

[1] The maternal uncle is here addressed very disrespectfully.

[2] *Śittappa* is father's younger brother, or mother's younger sister's husband.

Tamil	*English*
nān iḍapan karēl paḍutu kaḍapēn,	I will be sleeping beside the kitchen
ōyi, etc.,	stove, *ōyi*, etc.,
vēlūril śandy yānāl, māmā, etc.,	if there is a fight on at Vellore, *māmā*, etc.,
nān vēli ōratti paḍutu kaḍapēn.	I will be sleeping beside a hedge.

Humorous Song : *The Sick Man*

1. Oḍumbukku ennamō teriyale,	1. I don't know what is wrong with me,
kyye kaṭṭanam,	I must show my hand,[1]
naḍandāl pādy va*l*iyāi teriyudu,	if I walk, the road looks quite clear,
nālu munru ē*l*āyi teriyudu,	four and three together appear to be seven,
ōḍināl kālu u*l*ire kiḷambudu.	if I run, the legs go up.
2. Minnal minnudu, iḍi iḍikkudu,	2. Lightning flashes, thunder thunders,
mēkam kaṭṭudu, irunḍu pōgudu,	clouds gather, it darkens,
annāndu pārtāl tūṭral tūrudu,	if I look up, drizzling rain pours in drops,
appuram pārtāl tannīram ōḍudu.	and then, if I look, water will be flowing.
3. Kaḷḷy kuḍittāl vayiru nirambudu,	3. If I drink toddy, the stomach gets full,
kāśiyāi kuḍittām ma*l*akam varavudu,	if I drink *gānjya*, I will feel drowsy,
piḷḷy manyvi eṭṭi udykkudu,	I feel like kicking my wife (and) child,
pōlīsāriḍam udypadaceyudu.	and then I myself receive kicks from the policeman.
4. Annatte pārtāl valleyāi teriyudu,	4. If I see a swan, it looks white,
aḷḷi vyttadum vā*l*um terakkudu,	if I take food, the mouth opens,
aryttu taḷḷināl uḷḷe pōgudu,	if I take powder (medicine), it goes inside,
appuram pārtāl paśiyum eḍukkudu.	and then, hunger begins.

TWO FOLK TALES

(1) *The Clever Fox*

There was a cucumber garden, and whenever the plants put forth tender cucumbers a pack of jackals would invade the garden and eat them up. And then they would rub their buttocks against the big cucumbers. One night the gardener stuck a number of knives into the big fruits. A fox came and ate a number of tender cucumbers, and then tried to rub its buttocks against a big cucumber. The knife tore up the buttocks. The fox, though greatly hurt, and bleeding, took a few cucumbers with him, and went to the *kulavan* (potter). It asked the potter to give a small pot (*kaleya*) in exchange for a cucumber. The potter agreed, and the exchange took place.

Then the fox went to a Śeṇiyan (weaver) and asked him to give it a piece of cloth in exchange for a cucumber. The Śeṇiyan agreed to it. Then the fox put all the mucus and blood into the pot, covered it up with the cloth, and made its way to a Veṭṭiyan (drummer). It asked the Veṭṭiyan to exchange a pot of ghee for a drum. The greedy Veṭṭiyan thought it was a very good bargain, and was only too glad to make it.

[1] The Ayurvedic Pandit feels the pulse of the patient to diagnose the disease.

He took the pot, trekked back to his house, and opened the cloth to find that inside was only a mess of blood and mucus. Meanwhile, the fox sang beating the drum, '*sīla kuḍutu mōla vāngine śinjān, śinjān* (I gave mucus and bought a drum).'

(2) *The Two Sisters : Mūdēvi and Śrīdēvi*[1]

A very poor couple, of whom the husband was bone-lazy, lived in a village. Even hunger would not drive the husband to work (Mūdēvi is supposed to make a man lazy). The wife did odd jobs in a rich man's house, for which she received the left-over food. The wife constantly rebuked her husband, but in vain. But one day, however, he told her that he would go to the forest and cut fuel if only he were given an axe and a sickle. The wife went to her parental home and secured the two implements.

The wood-cutter went to the forest, selected, in his ignorance, a beautiful sandalwood tree, and started hacking it. Immediately two sisters appeared, and asked him to refrain from cutting the precious tree in which they lived. The wood-cutter told them that he had to live. Immediately, the elder sister (Mūdēvi) gave him a gold ingot and asked him to refrain from cutting the tree. The joyous wood-cutter immediately left the jungle and made for home. The sun was hot, and on the way was a pond. The wood-cutter, intending to take a bath, removed his clothes, kept the ingot on the bank, and got into the water. A *Verāl* fish mistook the shining ingot to be a fish, and swallowed it. The wood-cutter, on getting up from his bath, found his treasure missing. He went home and told the tale to his wife who promptly told him that he was telling a very tall story.

The wood-cutter made a bee-line for the sandalwood tree next day. The two sisters appeared before him and the elder abused him for his greed in coming again. He told her that he had lost the thing. The elder sister then gave him a necklace, and the wood-cutter wrapped it up in a towel. Again, on the way home, he felt like a bath, so he kept the towel on the bank, and got down to bathe. A brahmani kite mistook the towel for a snake, and pounced down upon it, picked it up, and flew away. The broken-hearted man went home to receive abuses again. The wife told him, "If you are given anything, why not bring it home first, and then go for your bath ?"

He went again next day and the elder sister gave him a bag of *Varahas.* He carried the bundle home, and not finding his wife, he dug a pit under the stove, and hid the coins there. He covered up the pit, and went for his bath.

[1] 'Mūdēvi's business is to make all living creatures drowsy and tired ; the rich, poor ; the high, low ; the honoured, hated ; and all men miserable. She dwells in dark places and joins those who are bent upon doing mischief. . . . Her various names are (1) Cheshta (the elder sister) ; (2) Keṭṭāi (she who ruins) ; (3) Kalathi (she who confuses) ; (4) Mugadl (poverty) ; (5) Tavvāi (elder sister to Laksmi, or Śridēvi) ; (6) and Indraikkmuttāi (elder to Laksmi). She receives no offerings, nor is she worshipped in any pagoda.' —*The Genealogy of South Indian Gods*, page 91.

Meanwhile, the next door neighbour came to borrow some fire. Not finding the woman at home, she went into the kitchen and poked the stove. She discovered the bag, took it away with her after covering up the pit.

That evening when the husband and wife met, he told her how clever he had been and how he had hid it under the stove. The wife raked up the pit only to find it empty. She was in a rage, and beat the poor wretch.

The wood-cutter was convinced that the sisters were magicians, and he went to the jungle next day determined to pull down the sandalwood tree. As he hit the first blow, the younger sister (Śrīdēvi) came and gave him a pie, and told him that that pie would secure him happiness.

The wood-cutter went home to find his wife had secured from her mistress a big banquet that day. She asked him to buy a fish for the pie, and he brought home a *Verāl*. She asked her husband to fetch some wood to cook the fish. Soon he was up a tamarind tree, and lo! there was a necklace in the nest of a bird. He brought it home.

The wife, on cutting open the *Verāl* found the ingot and said, "I have discovered what you mentioned about the other day." Immediately, the two heard a voice on the other side of the wall, saying in fear, "I did not steal it. I only took what was lying about." And then the woman came in to hand over the bag of money.

The wood-cutter and his wife were happy ever afterwards.

Moral :—Even if Mūdēvi gives all the wealth in the world, it won't stay without the grace of Srīdēvi.[1]

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1 Even in Kannaḍa society, the belief in Mūdēvi is very great, and when a man becomes lazy all of a sudden the remark is made 'Mūdēvi must have got into him.' Mūdēvi is said to have been born along with Śrīdēvi during the mythological churning of the sea.

BOOK REVIEWS

The Conception of Surplus in Theoretical Economics. By A.K. Dasgupta. Dasgupta and Co., Calcutta, 1942.

THIS book is the result of the author's research work for the Ph.D. Degree of the London University. It attempts at defining precisely the various conceptions of surplus one comes across in theoretical economics, and to fix up the place of each of them in a system of economic analysis applicable mainly to capitalism.

Economists from early times have asked themselves the question how the various economic activities of man, production, distribution and exchange can possibly result in the creation of surpluses. Thus, the Physiocrats linked up the notion of surplus to a particular category of economic activity, *viz.*, agricultural production. The whole theory of rent in classical economics is an attempt to show that this payment for the original and indestructible powers of the soil in no way damages the proposition that in equilibrium price measures real costs consisting of efforts and sacrifices. Gradually, it became clear that we could look at the problem of surplus from the point of view, for example, of the producer or the consumer ; the surplus could be conceived of either in terms of product, or in terms of utility or subjective satisfaction. The surplus we call profit is still another category ; it is connected with the machinery of distribution and the determination of rewards to the factors of production. There are also all sorts of monopolistic and quasi-monopolistic gains, speculative surpluses and windfall profits, each one of which would need a special treatment. Naturally, then, one asks oneself : What precisely do these surpluses connote ? How do they arise ? Are they in some sense 'real' ? Do they have any relevance to the problem of welfare and, therefore, to the shaping of policy? One sees immediately that the problem of surplus which seems at first sight to be somewhat of an out-of-the-way enquiry is in reality intimately connected with the method and purpose of economic analysis. A surplus must by its very nature be a comparison between two magnitudes, call them costs and receipts, or inputs and outputs. But, what do these latter terms connote from the point of view of society as a whole ? Does price measure 'social cost' and 'social utility' ? And, so, an adequate examination of the problems of surplus becomes, in fact, a critical review of the whole theory of Value and Distribution and even takes us into the field of monetary analysis. It is in this light that one has to study this book ; it is, to repeat, a critique of the theory of Value and Distribution from a particular angle of vision.

The book is divided into three parts. Part I deals with Distributional Surplus in its static aspect ; Part II with Exchange Surplus, more familiarly known as Consumer's Surplus ; and Part III treats of the dynamic aspect of Distributional Surplus in the light of modern monetary theory. The author has given us in this work a close and careful analysis of the various theoretical issues arising in connection with the

several types or conceptions of surplus he deals with. The work reveals the author's mastery of analytical economics with all its recent refinements.

Starting with the problem of Distributional Surplus in Part I, the author shows quite clearly how much of the confusion in the theories of rent propounded by early economists was due, in the main, to two faults. Firstly, these economists concerned themselves with a comparison of aggregates like social cost and social return rather than with the problems of relative valuation—thus incidentally preparing the ground for Marx's skilful turning of their own weapons against their cherished conclusions;— and, secondly, they failed to distinguish between physical productivity and economic productivity. This is the main theme of Chapters II to V, which also bring out the true nature of the pricing process and the significance of the concept of opportunity costs in this connection. An appendix "On the Ultimate Nature of Costs" clears up the matter further by showing how the real cost concept breaks down as soon as you assume two scarce factors not used in the same proportion in the different lines of industry. The appendix also considers the various objections that have been raised against the opportunity cost principle, and demonstrates how, whatever may be the preferences of the owners of the scarce resources in question, equalisation of the price to the marginal expense ratio is a sufficient condition of opitimum production.

Chapters VI to IX, or what we have called Part II, take us on to the analysis of Consumer's Surplus in domestic as well as in international trade. The author starts by showing how the analogy between consumer's surplus and rent which is stressed by some economists is only of superficial significance. For, whereas the latter concept cannot be used as a measure of the nation's prosperity, the former has been devised precisely for that purpose. Unlike rent, consumer's surplus is something outside the national dividend, or distribuend, as the author calls it; whereas rent, at least according to some, is the most appropriate subject of taxation, consumer's surplus should be least encroached upon by way of taxation, and should even be increased through bounties, etc. However, the question is : Is there such a thing as consumer's surplus ? Is something really left over after the consumer has made his final purchase ? In order to get an adequate answer to this question, we have to see the concept as it has evolved from the good old distinction between value-in-use and value-in-exchange and the distinction between 'absolute' utility and marginal utility in Dupuit, to the Jevonian and Marshallian definitions in terms of the difference between total and marginal utility. It has been shown that Marshall's concept is much more recondite than the one we find in the earlier writers ; that Marshall was, in fact, aware of the many limitations of it which were pointed out by some of his contemporaries and are dwelt on by later writers ; and, that it would be difficult to quarrel with Marshall's logic if his initial assumptions—the assumptions of partial equilibrium analysis—were granted. The real criticism therefore is that these assumptions are themselves unsatisfactory, especially because of the impossiblity of interpersonal comparisons of utility and the illegitimacy of the assumption of constant marginal utility of money. Similar considerations apply to the use of the concept to measure and compare the

gains from foreign trade. We cannot sum up the indifference scales of the different individuals within the country. Secondly, the volume of the country's resources devoted to foreign trade does not remain the same through all the movements along the demand-and-supply curves. All that the consumer's surplus can convey is the broad notion that because of the possibility of securing certain goods by way of exchange rather than by direct production at home, the country's resources are utilised more effectively, and the consumer is better off because the national income is correspondingly increased and he is able to secure more goods per unit of resource spent by him. In an excellent appendix "On the Elasticity of Reciprocal Demand and the Terms of Trade," Dr. Dasgupta shows how Viner's criticism of Marshall's treatment of the problem with reference to particular cases turns out to be merely a misunderstanding ; for, whereas the former assumes an increase in E's offer at a given price per unit, Marshall had in mind an increase in relation to a given volume of imports. If this point is borne in mind, Marshall's conclusions are seen to be correct ; and, here, as in the case of domestic trade, the only question is as to the assumptions on which the Marshallian constructions are built up.

To turn now to Part III, the analysis of Distributional Surplus under dynamic conditions, under conditions, in other words, where not only change but uncertainty is present. This uncertainty may be a mere transitional phase, giving rise to economic friction, which only delays the attainment of equilibrium, or, it may be a more permanent element in the situation, therefore necessitating a special treatment. The former type of uncertainty gives rise to temporary surpluses, which tend to be wiped out as expectations become more and more certain, whereas the latter gives rise to profit as a distinct share in the national dividend. The analysis of profit as a residual share claimed by the entrepreneur comes into its own only when this uncertainty is taken into account. Whether profit in this sense can be positive or negative on the whole, that is, over the economic system as a whole, would depend upon whether economic forces do or do not actually tend towards equilibrium. At this stage, it becomes imperative to consider the role of money, in terms of which alone all economic calculations and adjustments take place. As Dr. Dasgupta, following recent authorities on the subject, has rightly pointed out, the characteristic role of money as a liquid asset can only be discussed under the assumption of uncertainty, for money which is a mere counter is not the money which people are after in the real world. Money alters the very character of the economic process, and gives rise to profits or losses over the whole economic system, and so generates further conditions of change or movement, which may become cumulative in one direction or the other. In this connection, the author reviews briefly the recent theories of the Trade Cycle propounded by Wicksell, Hayek and Keynes, and shows how at least some of the divergences in their conclusions are traceable to the differences in assumptions or modes of approach. In any case, the relevant point which the author seeks to emphasize from the point of view of the subject-matter in hand, *viz.*, the emergence of surpluses and their significance, is that the present system based on free enterprise and the profit motive can be saved only if these 'chance' surpluses, as we might call them, can be regulated and controlled by a judicious monetary policy aiming at some sort of stabilisation.

So far regarding the scope of the work under review and its general approach. Is it necessary to say specifically after all this that the work is undoubtedly an able survey of the various conceptions of surplus, and succeeds in presenting a clear analysis of the same? As we pointed out at the very outset, what we have here is a careful examination of the theory of Value and Distribution in analytical economics from a specific point of view. Dr. Dasgupta is well known as one of our promising younger economists who have shown themselves capable of handling abstract issues in 'Pure Theory,' a subject which has hitherto not received as much attention by our economists as it probably deserves.

It remains only to add that while there will be general agreement about what Dr. Dasgupta has to say about the various surpluses he has dealt with, his remarks on the merits of free enterprise and the general predilection he has shown in favour of the capitalist system will fail to evoke a sympathetic echo in many minds. "The system of private enterprise," writes Dr. Dasgupta, "is only a method of grappling with the fact of uncertainty;" but he adds in parenthesis, it is "perhaps the most efficient method yet devised." That, surely, is poor consolation. It may be the most efficient system "yet devised" for general applicability, but opinions of experts as to what Soviet Russia has achieved cannot be quite valueless. Again, is it really true that "entrepreneurs have a tenure of office during good bahaviour"? Or, is Dr. Dasgupta falling into the error of assuming that the capitalist system as we know it is in reality the same as the conceptual capitalism of the economists? In any study of surpluses, just as we cannot avoid an examination of the role of money and monetary policy, we cannot also avoid an evaluation of the institutional framework of society. The recent developments in imperfect competition theory are an effort, some would say still an inadequate effort, in this direction. Apart from the broadly humanitarian aspects of a way of ordering life in which the initial distribution of the means of production and the subjective scales of valuation are taken for granted, one would like to know whether the present sytem does or does not create surpluses, positive or negative, which are attributable to this institutional framework. Dr. Dasgupta, commenting on Marx's theory of surplus value, remarks: "It is certainly not true that capitalism . . . . . contains in it anything that makes for monopoly in general." Once, again, it is a question of defining capitalism, and Dr. Dasgupta refers to "a normal way" of doing this, which by implication seems to denote for him a way in which monopoly and monopsony are only exceptions. Can we really judge capitalism even as a way of dealing with uncertainty apart from its system of social classes? Can we neglect to note the essentially dynamic character of that system? Does not the institution of private property and inheritance create relative scarcities of the factors of production having but little correspondence with natural scarcities? Such questions belong undoubtedly to a different terrain of thought. But, just as it is important to contemplate the working of the price-mechanism in all its mysterious spontaneity on the assumption of given scarcities of factors, it is also necessary at some stage to raise the question why these scarcities are what they are. Not until the latter is done can we offer any judgment as to the suitability of capitalism as a mode of combating the basic problem of scarcity. This, however, is not to deny the value of division of labour in this field, or to minimise the significance of the former type of analysis. A fine piece

of work, such as the one before us, must have its own high place, whatever the bounds the author fixes for himself for the time being.

J.J.A.

The Aboriginals. By Verrier Elwin. Humphrey Milford, Oxford University Press, July 1943, pp. 32 ; Price 4 Annas.

THIS pamphlet dealing with primitive folk in India is important, for it deals with the fate of 25 million Indians. And what affects them affects India as a whole, and should be the concern of every thinking Indian. It is also important because Mr. Elwin claims to speak with the authority of Science, and anthropologists, especially Indian anthropologists, are offered the choice of either heartily approving his views, or openly dissociating themselves from them. Finally, Mr. Elwin is a popular writer on the aborigines, and his views might easily be taken to be representative.

We shall state Mr. Elwin's case first, but very briefly. Among the 20 or so millions of the 25 million aborigines in India there is, what Mr. Elwin calls, "loss of nerve." This is due to the aborigines' contact with the British Government, the Christian Missionary, and the third, the worst of them, the semi-civilized Hindu or Muslim from the plains, who goes to the aborigine as landlord, lawyer or tradesman. Another deplorable contact is the "puritan Hindu reformer" who wants the aborigine to give up drink and dance. The contact with the British Government deprives the aborigine of his land and of the freedom to live by shifting cultivation. It gives him an education that in addition to teaching him a "useless literacy" makes him despise his fellows. It suppresses home distilleries, and destroys the right to hunt and fish. All these deprivations have brought about a total loss of joy in living, and resulted in "loss of nerve." Mr. Elwin discusses the several solutions that are offered for the aborigine's betterment : (1) Converting the aborigine into Christianity—he rejects as it severs him from the life in which he has his roots, and often leads to his moral and economic degradation ; and converting the aborigine to the "conventional village Hinduism" frequently places him at the lowest rung of the caste ladder, and makes him adopt "those very social evils that the best Hindus are to-day trying to abolish." (2) The "geographical solution" which consists in bringing the hillmen down to the plains, Mr. Elwin thinks to be the "most cruel and destructive" and leading to their "economic collapse, moral and psychic despair." The political solution (offered by the British Parliament) which fenced them in with Excluded, and Partially Excluded, Areas, he approves in principle, though he feels that their administration ought not to have been entrusted to an over-burdened Governor. His "scientific" solution is strangely similar to the political one offered by the British Government, and he advocates isolation and protection for the aborigines. "Some anthropologists would like to establish National Parks or Reserves where they (aborigines) could live their own lives in unhampered liberty . . . . . Simple children of nature may be protected from those who invariably exploit them . . . ." (p. 29). He rounds off the discussion with the surprising statement, "There is no possibility in India and the world as things are to-day of

substituting civilization for primitiveness : the only alternative to primitiveness is decadence" (p. 31, italics mine).

The "loss of nerve," a conveniently vague expression, which Mr. Elwin claims to have noticed here, is only a later form of the "loss of interest in life" which W. H. R. Rivers noticed among the Melanesians. Among the Melanesians, however, it was concomitant with a solid and verifiable fact, *viz.*, depopulation. Even then, some of the later observers like Lord Olivier denied there was anything like "loss of interest in life" among the Melanesians, and attributed depopulation to the more obvious causes of imported drink and diseases, and starvation. A recent observer like Mr. Tom Harrison (who, we may note in passing, is also a biologist) while admitting "loss of interest in life" puts it at the bottom of the list of the causes of depopulation. (*Savage Civilization*, London, 1937, p. 274). And the fact remains, if we trust the Census Reports, there is nothing like depopulation among the Indian aborigines. So when Mr. Elwin talks of the "loss of nerve" he is not speaking the language of science.

On p. 14 Mr. Elwin says "the aborigines were faced with a *serious crisis* (italics mine) when British administrators insisted on the cessation of such obviously evil practices as human sacrifice, head hunting, and murder for witchcraft." And owing to contact with the Government, the aborigines suffered "loss of independence," while the Christian Missionaries "attempted to interfere even more drastically with tribal life." These attempts "demoralised the people, destroyed tribal solidarity," forbade feasting, "decorations and the romance of communal life." But in the same breath Mr. Elwin maintains that the above two influences were only of "*an external kind and did not greatly affect the inner spirit of the tribes*" ! (italics mine). "Far more serious today (as a disruptive force) is the great wave of semi-civilized influences that is sweeping across tribal country" (p.14). So while the British Government's and the Christian Missionary influence were only external, the influence of the Hindu or Muslim plainsmen is eating up the core !

Mr. Elwin also condemns the Government for insisting, although half-heartedly, on the abolition of *bewar* or shifting cultivation. The latter consists in the ruthless denudation of the most valuable forests once every 2 or 3 years to practise a most outworn and superficial system of "cultivation." A good may tribes like the Chakmas of Bengal, Lepchas of Darjeeling, Savaras of Orissa and Mikirs of Assam have all changed over from *bewar* to settled cultivation. Mr. Elwin still maintains that *bewar* ought not to have been suppressed, especially so in the case of the Baiga, as they believe that using the plough is to "tear up the breasts of Mother Earth." Does Mr. Elwin seriously maintain that the plough should never be introduced among the Baigas ? Can a belief be allowed permanently to obstruct progress ? Mr. Elwin here forgets a fact which every tyro in Anthropology knows : Cultures are never static, but dynamic. Old traits are thrown off or modified, and new ones adopted. And that is life. Of course, a certain immigrant trait may be disastrous to the group. But that has to be proved in *every* case. There is nothing to prove that the Baigas are incapable of taking to agriculture. We may have to do it with special caution and slowness, but that is quite different from maintaining that it can't be done at all.

We shall now consider the "scientific" solution offered by Mr. Elwin. The aborigines are to be fenced off from the rest of the population, and needless to say, there will be any number of such "aborigine-islands" in our country. The effect of such a measure on the growth of national unity needs no comment. Any charlatan is given free rein to make political capital out of it. Exploitation of the mineral resources and the agricultural possibilities of forests are permanently opposed on the ground of "protection." Considerations of the economic growth of the country are set at naught. The world is changing rapidly every day, and temporary seclusion will only widen the gulf between the aborigine and his civilized neighbour. The adjustment has to be made some day, and delay may not only be dangerous, but fatal.

Mr. Elwin confidently urges protection in the name of "science." We may inform him of a very important discussion that is reported in *Man* (vol. XLIII, May-June, 1943, pp. 36-42), the official publication of the J.R.A.I., in which this question of the anthropologist's attitude to the aborigine is thrashed out. Lord Raglan, who initiated the discussion, says : "It must be realized that savage cultures are *bound to disappear and that something must take their place. Our civilization, with all its faults, is the best thing we know, and we are in duty bound to impart it, as far as we can, to our subject peoples. If we do not set to work deliberately to instil its best features there will be a gradual infiltration of the worst . . . . But the process of Europeanisation must take some time, and our first task should be to decide which savage institutions should be abolished at once, and which should be allowed to continue during the period of transition.*" (The italics are mine, and I make no apology for the long quotation as it is a direct answer to Mr. Elwin's claim to speak for "science").

The aborigine has been all along in contact with the very catholic Hindu civilization. Mr. Elwin himself says that aboriginal religion is a branch of the Hindu (p. 25). In some cases, as that of the Raj Gond, they have won a high place in the social hierarchy. Hinduism, or where they have absorbed enough of Islam, Islam then seems to be their natural destiny. But so far even thinking Indians have been utterly indifferent to the aborigines. Such an attitude must go, and at once. Every tribe should have an officer to regulate the contact of the aborigines with the outside world. Incidentally, anthropology can make use of the officer to collect the most valuable knowledge about tribal life, which, if not collected now, is lost for good.

Now for some facts mentioned in the Pamphlet : Regarding the racial constitution of India, Mr. Elwin gives us Von Eickstedt's classification without clearly mentioning the differences between the three groups. One especially misses any distinction between the "Weddid," and "Melanid" groups. The conclusions of physical anthropology with reference to India are not at all certain, as they are not backed up by any fossil evidence. (Incidentally, Von Eickstedt remarks in his introduction to A. K. Iyer's "Travancore Tribes and Castes," Vol. II, on the parallelism between his classification and Dr. Ghurye's classification, and the latter appears to us clearer, and corresponding more to the existing facts). Mr. Elwin describes (p.7.) Gondi language "as intermediate between Dravadia and Andhra tongues." We may inform Mr. Elwin that Telugu (not "Andhra" as he styles it) is also a Dravidian language.

We might leave it at that. Mr. Elwin's Pamphlet would have been of real service if it had merely stuck to describing facts accurately.

M. N. SRINIVAS

Regulation of Wages and Other Problems of Industrial Labour in India. By D.R. Gadgil. Gokhale Institute of Politics and Economics, 1943.

THIS book embodies the six lectures delivered by Professor Gadgil as Banaili Reader, Patna University, 1940. Let it be said at once that it is a highly stimulating and refreshing book. The first three lectures deal with the theoretical issues in wage regulation. They give a brief, yet excellent review of the currently accepted theories on the subject. The next two chapters deal with the problems of rationalisation and of industrial relations. The last one is devoted to an examination of the general and therefore elusive problem of the standard of living. In each case the facts are stated concisely so as to lay bare the essential character of the problem, and solutions are offered in the light of Indian as well as foreign experience. What emerges is a case for interventionism. That, of course, would be nothing novel, for which of us—Indian economists—is not an interventionist? The significance of the work before us lies in the fact that it is a *reasoned plea* for intervention, and it works out, step by step, the directions in which, and the lines along which, intervention has to be attempted.

The author sets out, first of all, the generally accepted solution of the problem of wage determination in terms of marginal productivity and "the maximum principle." He then examines the assumptions underlying the same, and states the grounds on which, so far at least as the Indian labour market is concerned, these assumptions are untenable. That the marginal productivity theory is essentially a static, long run theory has usually been well understood. Professor Hicks himself has made it clear that there is no reason why we should expect the wage a worker gets at any given time to be equal to the value of the marginal product. That also explains why when he goes on to analyse the determination of wages after a strike has been declared, he employs special tools like the Employers' Concession Curve and the Workers' Resistance Curve. On this point, therefore, there need hardly be any difference of opinion. Western economists do, however, believe that the model of a free competitive market is a reasonably close approximation to the actual market, and that therefore the analysis of long run problems may, nay, must, run in terms of marginal productivity. It is on this latter point that Professor Gadgil disagrees. "If a comparatively free labour market can today be said to exist anywhere, it exists in India" (p. 14), and yet such data relating to wages as are available show divergences and discrepancies which simply cannot be reconciled with the findings of accepted theory, even allowing for such factors as time lags, disequilibria, etc. "I, therefore, reject," says Professor Gadgil, "the theoretical structure raised largely on *a priori* grounds as unsatisfactory and feel that at least so far as India is concerned no theory which does not explain the facts of the situation adequately should be allowed to sway our judgments in matters of policy" (p. 20). This statement has certain far-reaching implications. It is a wholesome warning to those who would rush to draw conclusions applicable to policy in India in the name

of "theory" taken over from this or that author working under different assumptions. And yet, should it not also be pointed out that the condition laid down by Professor Gadgil for acceptance of any theory as a basis of policy is valid as much for, let us say, England as for India, for nowhere should a theory "which does not explain the facts of the situation adequately" be used to draw conclusions for policy? The danger is that this fact is often forgotten, and one must agree with the author's charge that even some of the eminent economists who should know better forget their own highly abstract assumptions and proceed to make recommendations as if the actual market was quite, or at any rate very much, the same as their theoretical construction.

Professor Gadgil thus asks us to divest ourselves of any lingering predilection we may yet have in favour of *laissez faire*, and proceeds to build up his case for regulation. This case, he argues, rests on three main grounds : (i) the unduly low wages in particular occupations and units, (ii) the undesirable effects of the possibility of the undercutting of wages by employers, and (iii) the difficulties created, for the maintenance of industrial peace, by disparities in wage rates between unit and unit (p. 40.) The last two points do not need elaboration.

As to point (i) above, it needs to be distinguished carefully from the problem of raising the general level of wages or improving the general standard of life of the working classes. This is a more limited objective, which reminds one at once of Professor Pigou's classic discussion of the problem of raising wages in occupations where they are particularly low or "unfair." But, as Professor Gadgil points out, there is a vital difference here. Whereas to Professor Pigou, it is a case of overcoming hindrances to mobility or reducing the costs of movement, to us it is a question of acting on the wage itself, for we have no standard of "fairness" in terms of a competitive wage in the light of which we could act. In this connection, the author reviews the recent theories as to the relation between the level of wages and the volume of employment—another difficult and controversial subject. He points out how modern economists, following Keynes, have come to realise more and more that a policy of wage reduction is not a cure for unemployment. The connection between wages and employment is, in fact, not so simple as to be capable of generalisation applicable under all conditions. "We are concerned," observes Professor Gadgil, "not with a regulation of money wages alone but with a possible regulation of real wages also;" but "no invariable connection between money wages and real wages can be theoretically postulated, and such light as statistical studies can throw on the problem seems to be yet meagre and inconclusive" (p. 26). The only way, therefore, is to work out the possible effects—shall we say, short term as well as long term—of wage regulation in India, under prevailing conditions, on the volume of employment offered. It would be too much to attempt to restate here the author's arguments on this point. This is inevitably a region where we can speak only of possibilities or probabilities, never of certainties. The fact that a reduction of wages is no cure for depression cannot imply that a raising of wages in particular industries in "normal" times would be harmless. The result would depend not only on the secular and cyclical trends in industry, but also on a variety of psychological and institutional factors, the exact incidence of which it would be so difficult to judge. On the

strength of such indices and indications as we have, and Professor Gadgil is keenly aware of their limitations and guards suitably almost every statement he makes, it is concluded that the effect of a rise in wages in particular occupations and units would very likely be only to set up a tendency towards the elimination both of the least efficient workers and the least efficiently managed businesses from the field. In all probability, such regulation would tend to improve the efficiency of the workers concerned. Incidentally, it is also pointed out how flimsy is the evidence for the view often expressed that an increase in wages under our conditions leads only to greater absenteeism.

The case for regulation thus made out, the problem is, firstly, what is the best machinery to be instituted for the purpose ; and, secondly, what is the norm or standard up to which wages may be raised ? The discussion that follows will be familiar to those who have gone through the report of the Bombay Textile Labour Enquiry Committee, of which Professor Gadgil was a member. Here we have a sort of theoretical background to the practical recommendations of that report. The various possible agencies for regulation are discussed in turn, and it is concluded that the agency best suited for us is the State, that is, the Provincial Governments ; that the type of regulation most suitable for our purposes is the fixing of minimum wages ; and that the machinery most appropriate for the object in view is the Trade Board composed of representatives of employers and workers. This method would safeguard the necessary autonomy of the trade and ensure at the same time general compliance on the part of employers with certain minimum standards. In other words, though the level of wages to be maintained is to be determined jointly by the representatives of Labour and Capital the ultimate sanction behind it is the might of the State. The fixation of the minimum wage schedules is not to be attempted in terms of any single criterion, but in the light of several guiding factors, each of which may be given more weight or less according to the circumstances of the industry.

This is the solution the author has to offer, and few will doubt that that is the most promising line of action. It is necessary, however, to be clear as to the limitations of this scheme, and these are dealt with in the last chapter on "The Standard of Living." "Apart from those classes of workers who receive the lowest wages today, regulation of wages cannot be expected immediately to do much more for workers in general than bring up the rates in the low-paying units to a fair average" (p. 87). This is not, however, the end of our task. It is necessary to see not only that no categories of workers are paid an unduly low wage, but also to secure that the workers as a whole get at least a decent minimum. Here comes in the larger role of the State. It does not pay an individual entrepreneur to raise wages, for the benefit by way of improvement in efficiency, loyalty, etc., is not always reaped by himself. Moreover, as Professor Pigou has argued, under private enterprise, there is always an underemployment of resources in the education of the younger generation. There are also several other responsibilities which a modern State has to undertake. All these aim partly at raising the general level of wages indirectly, and partly at giving the worker that sense of fairness and security without which no stable economic order can be built. There is evidently an almost unlimited field for this kind of

activities by the State in India, for we are still very backward in this respect.

All this should be sufficient to show that the book under review manages to give within a small compass a wealth of closely reasoned arguments and a number of practical recommendations. It reveals a keen appreciation of the theoretical issues involved and also a scrupulous regard for the facts of each case—strong points which few books on the subject of Indian industrial labour could be said to combine.

In the course of this study the author has raised a number of theoretical and methodological issues, on which there is room for discussion. Let us take, for example, the question of "fairness" of wages. On this point, Professor Gadgil observes, "The economic wage reflects nothing more than the way in which any particular economic arrangements work. It has no social or ethical implications . . . . . Not only is there nothing 'fair' about a particular wage, but one may even go so far as to say that there are no special economical implications about particular wage levels" (p. 93). Is this not an overstatement? What, precisely, does the statement mean? If it means that "fairness" or "unfairness" of any payment is essentially a relative concept, that the so-called "economic" wage is "fair" only under the assumption that the valuations underlying the capitalist system are themselves acceptable to us, the statement would be unobjectionable. But that would not mean that the economic wage "has no social or ethical implications." On the contrary, would it not be truer to say that each particular wage level has necessarily certain social or ethical implications? When Professor Pigou called the competitive wage a fair wage, he has in mind only relative fairness; it is fair so long as you accept the broad results of the capitalist system with its free enterprise and the profit motive. Nor is it clear what Professor Gadgil seeks to convey when he remarks that "there are no special economical implications about particular wage levels." What does "economical" mean in this context? Could it mean "rational" as when we talk of an economical distribution of resources as being rational? Does the statement imply that the "economical" or "uneconomical" character of a particular payment or system of payments refers to something outside the economic system?

Finally, as one finishes the book, one cannot help asking oneself: what, then, is the use of economic theory? Professor Gadgil is all for a realistic approach: "In the sphere of applied economics, and I personally believe, in the entire sphere of economics, it is the facts of the real world that are our raw materials" (p.9). Quite true; but, are not the facts of the real world far too many and far too complicated? The facts of real life can never entirely fit into any theory, and the theoretician has no alternative but to catch hold of the basic facts and generalise on the strength of these. That some of the accepted theories of today turn out on trial to be rather useless for practical application is due simply to the fact that economists have hitherto been preoccupied with one particular conceptual model of the economic sytem, a model which was a good enough approximation to the real world some time ago, but is now almost hopelessly out of tune with reality. The need, then, is for other models, and perhaps a number of them. We could perhaps then discover what is and what is not compatible with a parti-

cular economic motivation and a particular arrangement of economic institutions. Very likely, judging from the author's other writings, he really agrees with all this, and the few statements commented on above have for him a different meaning.

J.J.A.

The Early History of Kērala. A brief summary of five lectures delivered by Prof. T. M. Krishnamachari, M.A., B.L., Maharaja's College of Arts, Trivandrum. Published under the auspices of the University of Travancore.

IN the course of five lectures on the subject the history of Kērala is traced from the very early times to 1120 A.D. The first lecture deals with the physical features of Kērala and the sources of its history. The Kērala country comprises mostly Travancore, Cochin and Malabar on the west coast region of South India, with Malayāḷam, an offshoot of Tamil, as the current language of the country. On account of its unique position and physical features the Kērala attracted from very early times traders from Phœnicia, Egypt, Rome, China and Japan. The sources of its history are mainly Tamil inscriptions on stone and copper, and Tamil Sangam works. The Kērala (or the Chēra) is a very ancient country, referred to by Kātyāyana and Patañjali. The country was otherwise called *Paraśurāma-kshētra*, the Paraśurāma legend "enshrining a possible geological fact that the country was once under water which extended up to the Ghats and was reclaimed by volcanic action."

The second lecture deals with the history of the Chēras, their kings during the Tamil Sangam period and the social condition of the times. The sources are generally the Sangam works in Tamil literature, which date back to the early centuries of the Christian Era and are earlier than the earliest epigraphical records extant in the country. Two of the most important Chēra kings, known so far, of the early period are Udayan Chēral and Śen-Kuṭṭuvan. The latter extended his rule far and wide into the Tamil countries on the east of South India, and over Mangalore, Coorg and the modern Salem and Coimbatore districts on the other side. This early greatness of the Chēra supremacy was shattered in the famous battle-field of Tālaiyālankāṇam. Regarding the capital of the Sangam Chēras the lecturer merely summarises the two controversial views, one in favour of Vāñchi, near modern Cranganore, and another in favour of Karuvūr in the Trichinopoly district.

The political, social and religious conditions of the Early Kērala were in common with those of Chōla and Paṇḍya kingdoms in presenting an admixture of northern (or Aryan) and local (or Dravidian) ideas. The form of Government was monarchy. The Chēra kings enjoyed life to the utmost, but they did not fail to work hard at the kingly office when necessary. The Chēras had also a good fleet, which was an important factor of their military equipment. Women had a large amount of freedom, but they seem to have been inspired by high ideals of conduct and proved very noble mothers, setting a high standard of morals before their children. The worship of Vedic and Purāṇic Gods had come into existence. Koṟṟavi was the native tutelary Goddess with her

abode in the Aiyri hill. Jains and Buddhists lived in their monasteries and were allowed free observance of their religious practices. The attitude of the State to these religions was one of beneficent tolerance. The country was mainly agricultural, though in towns trades and handicrafts flourished. The early Kērala period is famous for its foreign trade, particularly with Rome. The trade in articles of luxury showed a considerable balance against Rome, which was paid in gold. The trade extended also to the Eastern Archipelago and China.

The third period, 300—825 A.D., appears to be a dark age in Kērala History. From 825 A.D. onwards the Kērala country was completely shut out from the Tamil land. The Brahmans who came to Kērala off and on in small batches adjusted themselves to local conditions. The form of worship they pursued was an admixture of both Aryan and Dravidian (or northern and southern). They styled themselves *Nambūdiris* and followed rigid caste observances and a peculiar marriage arrangement, with the system *Marumakkattāyam* succession unknown in other parts of India. They had besides unshared control of religion and a socio-political organization, of which they were the apex. Next in order were warlike Nāyars, the indigenous inhabitants of Kērala. The Jews seem to have come and settled in Kērala from the early centuries and obtained grants and charters from the ruling kings. The Syrian Christian Church is believed to have sprung up and grown in Kērala from the 4th century onwards. Both Jainism and Buddhism began to decline from the 13th century and after, so that they are now things of the past in Kērala.

For some time the Kērala was ruled by the kings of the Āy family, who were occupying the mountainous regions between the present-day Tamil and Malayāḷam tracts. For about three centuries the Kērala country was under the occupation of the Chōḷas. During the period of political and internecine disruption in the land the *Nambūdiri* Brahmans, like the Church in mediæval Europe, tried to save law and peace not only for themselves but for the common folk in the temples whose Gods became sovereigns.

The fifth and last lecture gives, among other matters of importance, a clear outlook of the social and economic life in the history of Kērala. The country was divided into *nāḍus* and villages, each having its own status, rights and privileges. The *nāḍu* conisted of both towns and villages, and had its own assembly. Every village had its temple wherein was centred not only the religions but the entire social life of the place. Some temples imparted education by maintaining Vedic schools ; they provided lectures and propagandist work for religion ; they provided also entertainment to the village folk by arranging dancing, drama or *kūttu*. The village population sought out its livelihood either by being employed in the temple itself or on the very extensive land allocated to it. The food problem was easily solved thereby. The temples focussed social instincts by developing a spirit of co-operation and social sympathy on a large scale. The villages were self-governing bodies with *sabhas* under the general supervision of the king or his officers. These *sabhas* looked after the Law and Order of the village. The land was fertile, yielding a variety of crops plentifully, rice being the staple food. The lands were accurately surveyed and boundaries were clearly de-

marcated. The foreign trade was brisk, and foreign merchants were always welcome to export the products of the country and import articles from outside, showing thus the far-sightedness of the Kērala rulers in the matter of the prosperity of the country.

It is hoped that Prof. Krishnamachari will bring out the labours of his extensive study and research on the early History of Kērala in a respectable volume and make a substantial contribution to the Early South Indian History, and that the Travancore University will give him all the facilities and encouragement needed for such an important work as this.

H. C. IYENGAR

Financial Burden of the War on India. By Professor C. N. Vakil. Pp. xii + 140, Bombay, 1943 ; Price Rs. 4.

WITH the usual thoroughness and clarity, Professor Vakil has examined here the problems of war finance in India. He has shown with striking success the dangers and the harmful effects of the methods of war finance that are being pursued by the Government and, at the same time, has worked out an alternative scheme. This, while promising to meet equally effectively the war needs of the State, is, clearly, better calculated to serve national interests.

Academic discussions on practical problems, specially in the region of economic policies and methods of the State, however, are not likely to be fruitful of concrete results in a dependent country. Expert economic opinion in India, peace or war, is not known to go far beyond academic precincts. The Administration can have little or no use for such opinion, guided, as it necessarily is, by another category of experts whose duty it is to weigh every economic measure and line of policy in the light of their effects upon another and a conflicting body of interests. This would seem to explain the striking absence from the Indian secretariats of economists of this country. In contrast, in nearly every country to-day, the leading lights among economists have been taken up, in one capacity or another, by the Government departments, especially the Treasury, the Ministry of Economic Warfare, the Ministry of Post-war Reconstruction and the like. There is hardly any well-known contemporary economist who has not been called upon to serve his King and country by giving the benefit of his expert knowledge and advice. In India, where different considerations prevail, we have a different story.

This does not take away anything from the importance and value of Professor Vakil's contribution. The public must be told where and how we stand in respect of our war-time finances. And the book represents a very able exposition of the problems of war expenditure in the Indian setting, war-time taxation and revenue, the composition, variation and incidence of public debt, the scope and effect of voluntary and involuntary savings, the causes, the evil consequences and remedies of inflation, the origin, the present context and the destiny of the sterling paper acquired by the Reserve Bank of India and many another allied problem.

Special mention must be made of the contribution of Professor Vakil to clear thinking on the question of the sterling assets in the issue department of the Reserve Bank, which seems to have been surrounded by a mist of propaganda from interested quarters. Professor Vakil has put these assets in their proper place. Neither our politicians, nor our traders, nor, indeed, the State can have any legitimate claim over them for importing essential machinery, to further any scheme of post-war reconstruction or for liquidating the external debt of the Government or the country. It is not as if they are in the nature of a nest egg to be drawn upon for tiding over exigent needs. They are the property of the Reserve Bank held by it against the liability of the notes issued by it to the agents in India of the British Government on whose behalf they were presented to the Bank. They cannot be got hold of by anybody—their replacement by Government of India rupee securities, which is not quite a legitimate procedure, apart—except by withdrawing from circulation equivalent currency notes. And such withdrawal of notes would raise the very problems to avert which the sterling assets were printed and the notes issued against them.

Professor Vakil has also shown that these so-called sterling assets are no assets at all but a measure of the economic liability that the country has been called upon, involuntarily and covertly, to bear on behalf of Great Britain. It is a measure of the inflationary taxation imposed upon India for the benefit of the British Treasury. So far from representing British generosity to her dependency, it represents Indian generosity, albeit extorted without our approval or knowledge, to Great Britain. They are a cunning device of saving the British economy of so much inflation and of procuring from India war materials, other goods and also gold for nothing. For, the cost of these assets to the British Government is no more than the cost of the paper on which they are printed. Professor Vakil's exposition should finally silence all nonsensical discussion regarding these assets, in which different people prescribe different uses for them.

The British Press and the British spokesmen in India, however, have dramatised this phenomenon as a crowning instance of British fairplay by India. *The Economist* (March 6, 1943, p. 302), for instance, observes that "Every bullet of Indian manufacture discharged by Indian soldiers in the Burmese campaign is paid for on the nail in sterling." It would be economically far more correct to say that it has been paid for by imposing reduced consumption on the Indian public through inflation. After reviewing the amount of sterling accumulated with the Reserve Bank the same paper, with a sense of elevated moral triumph, adds: "There is little here of 'imperialist exploitation' it should be widely noted" (p. 302). One feels tempted to retort that if this is not imperialist exploitation it is inflationary exploitation. But it is exploitation nevertheless.

In the light of this view taken by this learned journal, the following comments made by it on the identical technique employed by Germany in the territories annexed by her makes very amusing reading. Says *The Economist* (August 24, 1940, p. 249) in an article entitled 'Scientific Looting':

"This does not mean, of course, that the owners of goods requisitioned or bought by Germans are not paid for by them—in the technical sense of the term. The Germans are too clever to resort to the crude form of looting, except in remote countries such as Poland. As a general rule they pay for everything and pay generously—with the conquered nation's own money. That is the point : no matter what form the payment takes, it is in fact always the monetary authorities of the conquered country who provide the cash. Germany in addition to inflating her own currency, is in a position to inflate the currencies of other nations.

"The method of payment in occupied territories can be summarised under the following headings : (1) payment in Reichsmark notes ; (2) payment with Reichskreditkassenscheine ; (3) acceptance of bills drawn on German Government departments ; (4) issue of bank notes by occupation authorities ; (5) settlement through exchange clearing ; and (6) payment with the aid of advances from central banks. *In each case the net result of the transaction is that Germany obtains something for nothing, and the financing of the purchase entails an expansion of currency or credit in the conquered countries.* Even when payment is made in Reichsmarks, it does not mean that the recipients are enabled thereby to buy German goods, for imports from Germany are strictly controlled."

This passage may properly be applied in its entirety to the inflationary phenomenon at present in process in India with the necessary verbal alterations such as reading Great Britain for Germany, India for conquered countries, sterling for Reichsmark, and so on.

B. R. S.

War and Indian Economic Policy. By D. R. Gadgil and N. V. Sovani. Gokhale Institute of Politics and Economics, Publication No. 10, 1943 ; Price Rs. 5 or 10s.

THERE is little doubt that war, especially on a modern scale, has its economic problems no less profound and no less absorbing than those of peace. The fairly large number of brochures and studies published during the last twelve months and the discussions of war economic problems we come across in the Press as also in the more learned journals are ample testimony of this. A scientific examination of the economic policy of the Government of India is essential as much from the point of view of the most economical husbanding of our resources during the war as from the more long-range point of view of post-war reconstruction. Towards such a scientific examination of Indian economic policy the book under review is a valuable contribution.

The book is divided into two parts : one, dealing with Currency and Prices, and, the second, with some of the broader issues of Policy, such as Price Control, the Control of Inflation, etc.

The thesis advanced in Part I is now quite familiar to students of the subject as well as to laymen. There is now an almost complete unanimity of opinion among economists as to the causes of our continued

currency expansion, the mechanism of the same in relation to the accumulation of sterling balances, and also the consequences of this policy, if adequate steps are not taken to counter them by comprehensive monetary and non-monetary control measures. This does not, of course, imply that all this was fully understood in the right perspective before this work was published. The attention of the public had been pointedly drawn, especially by Professor Vakil, to the fact of inflation and its dangerous implications. But, there is a great deal in this work which clarifies several issues in this connection on which even experts are not always clear. The verdict of the authors is that the present inflation is "deficit induced," "fiat money" inflation—inflation of a particularly dangerous type. They contrast in this context the methods of war finance adopted by the Governments of the belligerent countries in the West, and show how they have been trying hard to fight "the Battle of the Gap" when such a gap between total disbursements and total receipts by way of taxation and loans necessitates resort to some inflation. In this country, on the contrary, inflation has been the main source of war finance, for although taxation has been raised considerably, the response to Government loans has not been at all commensurate with the needs of the situation. The mechanism of the Sterling Exchange Standard has, in these circumstances, proved a useful and effective way out for the Government of India as well as for the U. K. Government. The issue of notes against sterling is, after all, part of the recognised rules of the Sterling Exchange Standard game. But, as the authors have very rightly pointed out, this "cover" against the currency has no value at all, for at present we simply cannot use this cover. "The talk of an adequate cover to the note issue in India," observe the authors, "is, therefore, patent nonsense." The plain fact is that whereas in normal times the accumulation of sterling would have automatically brought about an increase in imports through this improvement in purchasing power and would therefore have set certain corrective forces into operation, nothing of the kind can happen during war time, and a grave disequilibrium between the internal and external values of currency can go on developing with impunity all the while, making the task of restoring equilibrium after the war correspondingly more difficult.

Part II is devoted to a discussion of the correct financial and economic policy in India in view of the criticisms of the present policy advanced in Part I. The problem, as the authors put it, is threefold : (i) to raise adequate financial resources for Government, (ii) to direct productive organisation so that productive effort is maximised and turned into channels required for purposes of prosecuting the war, and (iii) to distribute the necessarily limited supplies of goods and services so that the proper production effort is helped and the most equitable distribution of consumers' goods is brought about. In other words, the problem is none other than that of making the most of all available resources, subject to the principle of least aggregate sacrifice. More taxes and more loans are the inevitable consequences of such a policy, and although care must be taken to see that the burden of additional taxation falls on the right shoulders, there is no escape from it, whatever vested interests may say. Compulsion in respect of loans is always a difficult matter, especially for a Government placed as the Government of India at present is, in a rather unenviable political situation. How-

ever, the direction of all savings of the community, voluntarily or compulsorily, into war loans is an inevitable part of an anti-inflationary or rather non-inflationary policy of finding war finance.

Then follows a plea for a more completely co-ordinated and highly centralised system of controls. A policy of controlling individual prices is shown to be inadequate. Instead, the authors suggest a blanket control of all prices, a wage stop, a profit stop and a closure of alternative channels of investment. "The urgent need of the hour," they conclude, "is the formation at the centre from among members of the Viceroy's Executive Council of a directive economic committee." We have had sufficient experience, surely, of unco-ordinated sectional and piecemeal measures, and few would question the essential soundness of this recommendation.

The point at issue, then, is : Can the Government of India possibly launch upon the far-reaching measures of control and co-ordination advocated by economists today? That the present economic and financial policies are fraught with grave danger for the country is admitted on all hands. It is also admitted that modern Governments could be competent to deal with all these problems of war economy. The difficulty is not absence of knowledge as to the right means ; it is the absence of that main conditioning factor—full popular co-operation and support. But, at this point, perhaps, the economist ceases to have any say.

The book is on the whole a systematic and rigorous analysis of the problems of war finance and war time controls. It shall not be said of Indian economists, at least in the present crisis, that they came out with their solutions only too late, or that they failed to lay bare before the public and before the authorities all the consequences of the policies actually being followed. Curiously enough, there is at present a Consultative Committee of Economists whom the Government consult in regard to post-war problems, but, evidently, current war problems and policy are another matter !

J.J.A.

Iraq. By Seton Lloyd. Oxford Pamphlets on Indian Affairs.

THIS pamphlet makes a successful revelation of the imperialist mind of the writer. The small State of Iraq has been built by Britain at the end of the last war and is being 'served' by the British officials. Small though it is, its social, agricultural and political problems are, according to the writer, as complicated as those of ours in India.

Mr. Seton Lloyd bewails the failure of the democratic institutions in the East where they are inseparably connected with "administrative weakness, nepotism and patronage." Such omnibus observation on the capacity of the Eastern nations by a representative British writer is not only undeserving but unseemly as well at the present juncture when many of the Eastern nations are sacrificing their men and money in the cause of the Allied victory.

In the course of the pamphlet the author admits that the Note-issue in Iraq has expanded over six-fold without a corresponding increase in the goods or the bullion in the treasury of the State, and still the author emphasises that Iraq has no "inflation" of currency because "Denar is still tied to the sterling." This is a strange economic theory.

P. M. T.

An Atlas of the U.S.A. 19 maps with explanatory text. By Jasper H. Sternbridge. Oxford Pamphlets on World Affairs.

THIS little pamphlet makes a welcome addition to a scanty geographical literature available in India. It is perhaps an attempt on the part of the author to bring about a more intelligent understanding between the peoples on two sides of the Atlantic. To what extent has the author succeeded is a matter of opinion. For the Indian public, however, the pamphlet makes refreshing and thought-provoking reading, particularly when we realize the glory of the statue of Liberty at the entrance of New York harbour and a strong Federal Government at the Centre which symbolize the unity among the competing economic differences and conflicting interests of the various States. The suppressed yearning for freedom and the political unity of India find a proper echo but the Indian mind is left to brood with poignancy in a state of helplessness.

The singular merit of this pamphlet lies in its beautiful maps which are bound to be both educative and instructive. The map on the globular projection in the middle of the pamphlet is a contribution in itself to the intelligent understanding of the international affairs and the position U.S.A. occupies vis-a-vis the Allied countries and the Axis

In a convincing style the author has described the vast economic resources of the U.S.A. and the part which they are likely to play in the world affairs during and after the war. Incidentally, the author also emphasises a great work which the U. S. Government is doing for the social and economic amelioration of the great American Nation with care and enthusiasm which a task of this magnitude ever involves.

A perusal of the pamphlet is bound to be helpful and Mr. Sternbridge deserves our warm congratulations for bringing out this pamphlet.

P. M. TRIVEDI

Our Economic Problem. By Professors P. A. Wadia and K. T. Merchant. New Book Company, Bombay ; Price Rs. 6-8-0.

IN spite of the existence of several books on Indian Economics which are used by students and teachers in our Colleges, most persons who have given a thought to it have felt the need of a suitable volume which can give the reader in a well classified logical form the growing mass of material on the subject properly digested and analysed and presented with a sense of proportion. This task requires not only close familiarity with the vast and complicated problems of our economic

life, but also a freshness of outlook and method which may make the subject interesting and instructive and inspire the reader to further work. For giving us such a volume we are indebted to Professors Wadia and Merchant. The numerous students of Prof. Wadia, who has done more to inspire and create economists than create new economic literature, will be gratified to see the youthful enthusiasm and freshness of outlook of this veteran teacher, ably supported by his young collaborator who should be congratulated in making it possible for Prof. Wâdia to undertake this very useful task.

So far as the book itself is concerned it covers the problems of production, distribution and consumption ; the remaining problems of trade, transport and finance are to be treated in a companion volume. We notice that new topics such as "the Agricultural Proletariat," "the Future of Industrialism," "Problems of Consumption" and "Planning for Future" have been included in this volume. This shows that the authors have not merely followed the trodden path but have taken care to think out the problems for themselves in their proper perspective. The other interesting feature is the thoroughness with which the latest literature on every topic, whether Government reports, published works, articles or even unpublished manuscript theses, have been brought into service. This excellent effort to weave such a widely scattered mass of data into a coherent whole not only makes it easy for the reader to get the most recent facts, but also shows the more ardent student the avenues for further enlightenment on each topic.

It is not possible here to refer in detail to the views of the authors. It must be pointed out, however, that unlike the treatment of some current books in which there is a dull summary of arguments for and against a proposition, the authors of this volume make convincing efforts to arrive at scientific conclusions on the topics they handle. To give only one illustration, we may refer to the awareness of the authors to the dangers of the growth of capitalism in the country. The actual economic disadvantages of foreign rule often blind us to the potential dangers of unbridled capitalism. While the former must be removed without delay, it is good to realise even at this stage the full implications of the latter. The present inflation in the country has proved an interesting forerunner to what may be in store for us. While the man-in-the-street is crashing under its burden, and the independent economists have vigorously protested against it, the industrialists and capitalists have preferred to be silent about it ; in fact, in some cases indirect encouragement has been given to the inflationary policy. Besides, suggestions or efforts to combat it have met with opposition from these quarters. The authors have done well to bring out this point, and have also shown how our future economic policies will have to be guarded against the worshippers of Midas.

Among the objectives for economic planning for the future, the authors have laid down the following :—

"To raise the standard of living of the people, to bring to them by a many-sided development of our economic resources the possibilities of a fuller and a richer life, to provide improved transport facilities within the country, especially by the construction of roads and by the extension of motor transport, to develop our domestic industries, mainly subsidiary,

by rural electrification, adding indirectly to the amenities of rural life, and above all to create larger home markets for our agricultural products."

For obtaining both a conviction and a faith for a balanced economic life in the country this eminently readable volume will be found useful by all classes of readers, students as well as laymen. For the size of the book, 520 closely printed pages, the price of Rs. 6/8 is low. This does not mean that the high cost of paper and printing has not affected the production of this volume ; it only shows the very laudable desire of the authors to make the book available to a larger number of readers without thinking of personal profit.

C. N. VAKIL

Samrāt Priyadarśī, or the Emperor mistakenly supposed to be Aśoka, or the Jaina Emperor Saṁprati. By Tribhuvandas Laherchand Shah, L.M.&S. Sashikant & Co., Baroda, 1942, pp. 422, Appendices, Index, Plates and Maps, Size 9″ × 7″; Price Rs. 6-0-0.

THIS book seeks to shake the foundation of Early Indian History. Mr. Shah tries to prove that Priyadarśī, the author of numerous inscriptions carved on rock and pillars almost all over India was Saṁprati who was the grandson of Aśoka, and not Aśoka himself. The book is accordingly divided into 4 parts. Part I deals with chronology. Part II—Rock and Pillar Inscriptions, all attributed to Saṁprati. Part III—Other works of Saṁprati. Part IV—Life of Saṁprati.

The most important part is however the first where the grounds for discarding the accepted synchronism between Candragupta and Sandrókuptos and Aśoka and Piyadasi are given. In the three other parts Mr. Shah attributes all the rock and pillar inscriptions, the stupas at Sāñchi, Bhārhut and even at Pahārpur in Bengal to Saṁprati ! ! His argument is simple. If these monuments were not excavated or constructed by Aśoka or under his rule, then they must have been excavated or constructed by Saṁprati ! !

The reasons for the non-acceptance of the synchronisms mentioned above are that Mr. Shah does not believe in this far-fetched philologist's trick. If Sandrókuptos cannot be equated with Candragupta much less can he be equated with Aśoka, a synchronism which he is prepared to believe (p. 28).

He admits that the rock edicts do not mention either Aśoka or Saṁprati (p. 11). Is it not possible then that the name mentioned therein, *viz.*, *Devānāṁ Piyadasi* was a title used by Maurya monarchs ? A title used not only by Saṁprati as Mr. Shah tells us but also by Aśoka. For in the first line of Maski edict, which reads *Devānāṁpiyasa Aśokasa* . . . . . *adhati* . . . . which is usually translated[1] as "(A proclamation) of Devānāṁpriya Aśoka . . . . " Since the lapse of 2½ years . . . . "I am a Buddha śākya" . . . Mr. Shah interprets as "I (Saṁprati) have become Devotee since 2½ years 'with the permission' of Aśoka, Devānāṁpiyasa" (pp. 135-36). Even this emendation, *viz.*, the inclusion of such

[1] Hultzsch, *Inscriptions of Asoka*, cii (New Edition), Vol. I, pp. 174-75.

words as "with the permission of" does not strengthen Mr. Shah's case. He has himself admitted that the epithet *Devānāṁ Piyadasi* is used with reference to Aśoka. But by this admission he throws away his main plank. This directly contradicts his assertion on p. 12 that "in the Maski edict *Piyadasi* stands in relation of a junior and successor of Aśoka."

Likewise the entire superstructure built by Mr. Shah can be torn to pieces, but for this another volume—time, money and paper—will be required. It is true that foundations of ancient Indian history rest at present on tit-bits from foreign sources. There is a real need for the proper evaluation of Indian literary—Hindu, Buddhist and Jaina—sources ; particularly the Jaina, which hitherto has not been scientifically studied. If Mr. Shah who is a Jaina had confined himself to a clear analysis of the Jaina (ancient, mediaeval and late) literature and discussed its bearing on Early Indian History, indeed a reliable book or books would have resulted. While his present and previous books show a hopeless muddle; wherever it suits him, references are given: sometimes imperfectly given, sometimes not at all, so that certain chapters in Part IV look like novels. Equally this is true of the illustrations—particularly the frontispiece giving sketches of Aśoka and Priyadarśi, and Plate II and Plate XI. They will be extremely misleading to a lay reader. Mr. Shah's book shows, if anything, how history should not be written.

H. D. SANKALIA

How to Secure Indian Independence. By "Sutlej". Oxford University Press, October 1943, India ; Price 8 Annas.

THE pamphlet under review is an addition to the series of pamphlets on current topics published by the Oxford University Press. It contains a "blue print" of a plan by an "independent observer"—as the author, who prefers to shelter himself behind a pseudonym, calls himself—for solving the political deadlock in India, but this plan is based upon unscientific and unwarranted generalisations which are not supported by adequate or true facts.

The plan envisages the division of India into eleven separate States—Hindustan, Pakistan (whose detailed areas are given) and nine Indian Native States which would incorporate smaller Native States—and according to the detailed time-table given by the author, the United Kingdom is to transfer the sovereignty to them.

The author is absolutely unscientific in holding race as the basis of nationalism, in considering racialism as the strongest of political forces and in accepting the two-nations theory also based upon what he thinks the two major races of Hindus and Muslims. The author seems to be ignorant of political theory as well as historical evolution and facts. He has possibly conveniently forgotten that the majority of the present-day Muslims are the converted Hindus. His thesis of one race—one nation—one State is absolutely wrong and cannot be accepted ; else, all the modern States will have to be broken up and regrouped and the recently reported agreement at the tripartite conference at Moscow

about resurrecting Austria as an independent State will have to be abrogated.

When the author claims 90% of Muslims as the followers of the Muslim League he seems to be relying on the figures supplied by Messrs. Amery and Churchill to the House of Commons. May we remind him of the fact that there are a number of other Muslim organisations which have quite a substantial following and which are opposed to Muslim League and Pakistan, *e.g.*, the Ahrars, Jamiat-ul-Ulema, Momins, etc.? Then again, one is astounded at the categorical statement made by the author that Britain is pledged to grant freedom to India unconditionally. Does he not remember the categorical statements and various speeches of Churchill, especially regarding the non-applicability of the Atlantic Charter to India and his most notorious Mansion House speech (November 11, 1942) :—"We mean to hold our own. I have not become the King's First Minister in order to preside over the liquidation of the British Empire"? The author should re-read all the documents connected with the much-advertised and now defunct Cripps offer and also the statements and speeches of Cripps himself after the breakdown of the negotiations, and the utterances of so-called socialists like Morrison discovering the virtues of British Imperialism. The facts of the virtual recall of his personal representatives—Louis Johnson and Phillip—by Roosevelt, and Willkie's not visiting India at "the expressed desire of the President"—obviously under pressure from Churchill—must also be noted in this connection. If Britain at the lowest ebb of fortunes of war would not grant reasonable demands of India, is it commonsense to expect a victorious Britain to grant full freedom?

Moreover, the author has failed to grasp fully the economic implications of his division of India. In his discussion of details he has forgotten a number of important items like currency, Reserve Bank, mines, industries, etc.

The whole plan is a naive one, based upon wishful thinking which he advises others to avoid. This pamphlet has not the standard of the earlier pamphlets in the series and instead of making people start thinking afresh is likely to create more confusion and indifference by suggesting that the whole problem is so very simple and easy to solve.

K. T. M.

Economics of Indian Agriculture, Part I. By Dr. B. V. Narayanswamy and P. S. Narasimhan. Rochouse & Sons, Ltd., Madras, 1943.

THE authors discuss the principles of Economics as applied to Agriculture with special reference to India in the first few chapters and point out the importance of agriculture in the economy of the country.

The rest of the portion of the book is devoted entirely to Co-operation in India where the entire co-operative movement in the country has been subjected to a searching analysis. After a short historical sketch of the origin and growth of the co-operative movement and after pointing out that the hasty expansion brought about difficulties of supervision

and audit, the authors have critically examined the present position of the movement and have pointed out dispassionately its defects and achievements.

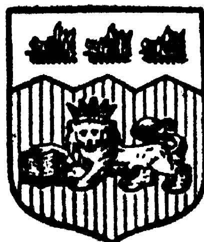
Dealing with the rôle of the Reserve Bank in respect of the co-operative movement the authors point out the great handicap to the latter in the lack of enough patronage from the former. In view of the peculiar nature of agricultural finance and the fact that the ultimate aim of the co-operative society is not so much to make profit as to place the farmer's economy on a sound footing, the movement is entitled to a special treatment at the hands of the Reserve Bank. The policy of the Reserve Bank towards the land mortgage banks has also been one of complete isolation.

However, the useful work in the sphere of research, guidance and advice done by the Agricultural Credit Department of the Reserve Bank should be appreciated. But here again, as the authors rightly point out, "the zeal of the Reserve Bank for criticism has hardly been matched by an equally ardent desire to help and in more than one instance the defects of the movement have been exaggerated."

The book, as the authors themselves say, does not add materially to the literature on Indian agriculture provided by various classical reports published by the Government and books by eminent writers on the subject. It seeks to put in a summary and easily understandable way the vast and scattered literature so far published on the many aspects of Indian agriculture. As a text on "Indian Agriculture" the book will serve a useful purpose to the students during the undergraduate course.

M. B. DESAI

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CONTENTS

INTERPOLATION AND SUMMATION FORMULAS AND THE PROPERTIES OF FACTORIALS—IV

By

DR. D. K. SEN

§ 6. INTERPOLATION FORMULAS

27. WE have seen in Art. 3 that any interpolation formula could be used for any value of x, within or near the bounds prescribed by the difference table. We shall now find the range best suited for each formula. The remainder-term which measures the error, consists of two essential factors (see Art. 2). As the range of the table is in general fairly small,—which is essential for a successful application of interpolation (*cf.* Art. 4),—the value of the derivative of the function will not vary much in this region. Hence it is the other factor which plays the deciding role in settling this question.

(i) *Newton's ordinary formula.* The factor just mentioned is $\dfrac{x^{(n+1)}}{(n+1)!}$; leaving aside the denominator, we have seen that $x^{(n+1)}$ or $F_n(x)$ has the least set of values in the range $\left(\dfrac{n-1}{2}, \dfrac{n+1}{2}\right)$ if n be odd, or, in one of the ranges $\left(\dfrac{n}{2}-1, \dfrac{n}{2}\right)$ and $\left(\dfrac{n}{2}, \dfrac{n}{2}+1\right)$ if n is even. So, the best range for this formula is near the middle of the range $(0, n)$. Doubtless, $F(x)$ is very small when x is very near an integer, but the value of the function will be smaller still if at the same time x be near the mid-range.

(ii) *Stirling's formula.* The deciding factor is $x^{[2n+2]-1}$ or $F_{2n}(x+n)$ in this case. This has the smallest values if

$n-1<x+n<n$, or, $n<x+n<n+1$,

that is, if
$$-1<x<1.$$

(iii) *Bessel's formula.* The factor in question is $x^{[2n+1]-1}$, or, $F_{2n-1}(x+n-\tfrac{1}{2})$. Hence the remainder term is least when

$$n-1<x+n-\tfrac{1}{2}<n.$$

or,
$$-\tfrac{1}{2}<x<\tfrac{1}{2}.$$

(iv) *Everett's first formula.* The factor is

$$(x-n)\,x^{[2n]-1}, \text{ or } F_{2n-1}(x+n-1).$$

The least values occur therefore when

$$n-1 < x+n-1 < n,$$

or, $$0 < x < 1.$$

(v) *Everett's second formula.* The factor is

$$(x-n-\tfrac{1}{2})\, x^{[2n+1]-1} \text{ or, } F_{2n}\,(x+n-\tfrac{1}{2}).$$

The smallest values occur therefore when

$$n-1 < x+n-\tfrac{1}{2} < n+1,$$

that is, when $$-\tfrac{1}{2} < x < \tfrac{3}{2}.$$

In the same manner the best ranges for any of the Gauss's formulas can be determined.

Our effort should however be to avoid placing an array of formulas before the computers for practical use ; and in choosing the one formula simplicity should be the guiding principle for, as we have seen, the degree of accuracy of every formula is the same if interpolation is carried out near the middle of the effective range. Judged from this standard Newton's ordinary formula appears to be the best for use, particularly if no arithmometer is available (See remarks on Aitken's methods in Art. 1).

One more point need be mentioned. The calculation of differences of the same order for two values of x is equivalent, or at least almost equivalent, to the calculation of a difference of that order and the next. Hence I see no advantage of one formula stopping at the difference of m-th order if it has to use two values of this difference, over another stopping at the (m+1)-th difference using only one value of every difference.

§ 7. A FEW APPLICATIONS OF NEWTON'S INTERPOLATION FORMULA

28. *Estimation of Population for any age-group when populations are given in other but equal groups.* Some previous writers (*cf.* J.I.A., 1909, *43*, 114 ; J.I.A., *50*, 32 ; Whittaker and Robinson, *loc. cit.;* Quarterly Pub. Amer. Stat. Assn., 1916) have obtained formulae by means of which an estimate of the population of only the middle year would be obtained for given populations of groups of $(2r+1)$ years, r being an integer. However, C. H. Forsyth had obtained a formula for the population of an individual age and of any fraction of any age-group. Although Forsyth has made use of the cumulative population and its difference table, the discussion given below is simpler, and the one result obtained, *viz.*, the formula (121), is very general inasmuch as it can give an estimate of population for *any new* age-group. The accuracy of the results will however depend on that of the interpolation formula used and on the range of the argument for interpolation.

Let us suppose that the following data are given :

age-groups :	x' to $x'+h-1$,	$x'+h$ to $x'+2h-1$,	$x'+2h$ to $x'+3h-1$,	....
population :	p_1 ,	p_2 ,	p_3	,.......

each age-group consisting of h individuals. Let us first form a cumulative population table with its differences, assuming that the population up to $x'-1$ ($\equiv x$) is p_0. It will be seen that this quantity will not enter in our formulas.

Upper Age-limit	Cumulative Population	First Diff.	Second Diff.	Third Diff.
x	p_0 or $f(x)$			
		p_1		
$x+h$	p_0+p_1 or $f(x+h)$		$\triangle p_1$	
		p_2		$\triangle^2 p_1$
$x+2h$	$p_0+p_1+p_2$ or $f(x+2h)$		$\triangle p_2$	
$x+3h$	$p_0+p_1+p_2+p_3$ or $f(x+3h)$	p_3		
....	....	..	..	....

We take the cumulative population as $f(x)$. Of course, we have to assume that $f(x)$ behaves regularly.

Suppose now that we wish to find the population corresponding to the period from $x+w_1 h$ to $x+w_2 h$, where w_1 and w_2 may be any numbers, integral or fractional, differing from each other by unity or otherwise, etc. Taking that the remainder-term is negligibly small, we apply the ordinary interpolation formula of Newton and get the required answer

$$
\begin{aligned}
&= f\,(x+w_2 h)-f\,(x+w_1 h) \\
&= p_1(w_2-w_1)+\triangle p_1\left\{\binom{w_2}{2}-\binom{w_1}{2}\right\} \\
&\qquad +\triangle^2 p_1\left\{\binom{w_2}{3}-\binom{w_1}{3}\right\} \\
&\qquad +\ldots+\triangle^{s-1} p_1\left\{\binom{w_2}{s}-\binom{w_1}{s}\right\}. \qquad (121)
\end{aligned}
$$

In continuing upto the $(s-1)$-th difference and no further we assume that the s-th differences are either zero or are too small to be taken into account ; if we use the remainder term it means that $\binom{w}{s+1} f^{s+1}(\xi)$ is quite small. The best results are to be obtained when w_1 and w_2 are near the midrange of the interpolation formula. The formulas of King, Lidstone and Forsyth can easily be derived from (121).

(i) Thus, suppose that the given upper limits of the age-group are $x+5$, $x+10$, $x+15$, $x+20$ and $x+25$, and that we are required to calculate the population for the mid. age, *viz.*, $x+13$.

The answer $=f(x+13)-f(x+12)$, so that $w_2=2.6$ and $w_1=2.4$. Taking terms up to $\triangle^4$ which is possible when data numbers five, we have the answer

$$=.2\,[p_1+2\triangle p_1+.96\triangle^2 p_1-.04\triangle^3 p_1+.00448\triangle^4 p_1]. \quad (122a)$$

which can readily be shown to be equivalent to

$$.2\,[p_3-.04\triangle^2 p_2+.00448\triangle^4 p_1], \quad (122)$$

the formula of King's. The term $2\triangle p_1$ of (122a) evidently suggests p_3 of (122).

(ii) Again, let us suppose that the age-groups are defined by their upper limits

$$x+(2r+1),\ x+2(2r+1),\ \ldots\ldots,\ x+(2r+1)(2r+1),$$

The mid. age is

$$x+r(2r+1)+r+1 \text{ or } x''+r+1, \text{ say.}$$

The population for this mid. age

$$=f(x''+r+1)-f(x''+r).$$

These make $w_2=m(r+1)+r$ and $w_1=m\,r+r$, where

$m=1/(2r+1)$. The required value is then

$$m=\Bigg[\Big\{p_1\Big\}+\Big\{r\triangle p_1\Big\}+\Big\{\binom{r}{2}-\frac{m^2}{3}\binom{r+1}{2}\Big\}\triangle^2 p_1$$
$$+\Big\{\binom{r}{3}-m^2\binom{r+1}{3}\Big\}\triangle^3 p_1$$
$$+\Big\{\binom{r}{4}-2m^2\binom{r+1}{4}+\frac{(1-m^2)(9-m^2)}{4^2.5!}\Big\}\triangle^4 p_1$$
$$+\ldots\Bigg], \quad (123)$$

after a little reduction. Now,

$$p_{n+1}=p_1+n\triangle p_1+\binom{n}{2}\triangle^2 p_1+\binom{n}{3}\triangle^3 p_1+\ldots.$$

Use this result by taking the first terms of the curly brackets together, then the second terms together, and so on. We shall then get Lidstone's formula for the population for the mid. age,

$$m\Bigg[p_{r+1}+\frac{m^2-1}{4.3!}\triangle^2 p_r+\frac{(m^2-1)(m^2-9)}{4^2.5!}\triangle^4 p_{r-1}$$
$$+\ldots\Bigg], \quad (124)$$

since $r(r+1)-(1-m^2)/4m^2$.

We can express the above in terms of p_{r+1} and its differences. We note in the first place that Δ corresponds to a change in x (or age) of magnitude $h=2r+1$, and that $p_{r+1}=\Delta f(x'')$. If we put $f(x''+r+1)$ $=f(x''+w'_2 h)$ and $f(x''+r)=f(x''+w'_1 h)$, we shall have $w'_2=\frac{r+1}{2r+1}$ $=m(r+1)$ and $w'_1=mr$. Therefore, the required population

$$=f(x''+w'_2 h)-f(x''+w'_1 h)$$

$$=m\left[p_{r+1}-\frac{1-m^2}{4\cdot 3!}\Delta^2 p_{r+1}+\frac{1-m^2}{4\cdot 3!}\Delta^3 p_{r+1}\right.$$
$$\left.-\frac{(1-m^2)(71+m^2)}{4^2\cdot 5!}\Delta^4 p_{r+1}+\quad\ldots\ldots\right]. \qquad (125)$$

(iii) Finally, let us derive, from (121), the value of the population corresponding to the age $x+r+1$. The required number

$$=f(x+r+1)-f(x+r),$$

making $w_2=(r+1)/h$ and $w_1=r/h$. Thus we have the answer after some simplification,

$$\frac{1}{h}\left[p_1+\frac{2r+1-h}{2h}\Delta p_1+\left\{3r^2+3r(1-2h)+(1-3h+2h^2)\right\}\right.$$
$$\times\frac{\Delta^2 p_1}{6h^2}+\left\{4r^3+6r^2(1-3h)+2r(2-9h+11h^2)\right.$$
$$\left.\left.+(1-6h+11h^2-6h^3)\right\}\frac{\Delta^3 p_1}{6h^3}+\quad\ldots\right]. \qquad (126)$$

If we replace $p_1, p_2, p_3, \ldots$ by $W_0, W_1, W_2, \ldots, r$ by x and h by t, we get the same formula as was obtained by Forsyth.

Further, if we put $w_2=(r+n)/h$, $w_1=r/h$ in (121) and perform a little simplification we shall obtain the result (5) of Forsyth (*Cf.* Quarterly Pub. Amer. Stat. Assn., 1916, 425).

29. Forsyth's problem appears to have been incorrectly stated in Whittaker and Robinson (Question 5, p. 69) inasmuch as W_0 and W_x are written in place of $W_{\frac{0}{t}}$ and $W_{\frac{x}{t}}$. This tends to give a wrong idea about the different W's which are to be used for the differences.

As a matter of fact, $\Delta W_0=W_1-W_0$, etc., where $W_0, W_1, W_2, \ldots$ stand for $W_{\frac{0}{t}}, W_{\frac{t}{t}}, W_{\frac{2t}{t}}, \ldots$

30. Let us restate the printed problem of Whittaker and Robinson (*loc. cit.*) : Given that

$$\begin{aligned} W_0 &= u_0 + u_1 + \dots + u_{t-1} , \\ W_1 &= u_1 + u_2 + \dots + u_t , \\ W_2 &= u_2 + u_3 + \dots + u_{t+1}, \\ &\dots\dots\dots\dots \\ W_m &= u_m + u_{m+1} + \dots + u_{m+t-1} ; \end{aligned} \qquad (127)$$

to obtain an expression for u_r in terms of W_0 and its differences.

If the u_t 's are the members of a time-series, the W_m's are t times the moving average of the u's taken over a period equal to t times the given interval between the successive members of the series.

The operator $\triangle$ is defined thus :

$$\triangle W_r = W_{r+1} - W_r ,$$

and $\triangle u_r = u_{r+1} - u_r .$

From the data we get

$$\triangle W_r = u_{r+t} - u_r = \triangle_t u_r , \text{ suppose.} \qquad (128)$$

And $\triangle^p W_r = \triangle^{p-1} u_{r+t} - \triangle^{p-1} u_r. \qquad (129)$

To be definite let us assume that $\triangle^p W_r$ is zero or very nearly zero, so that the required answer would involve differences of W_0 up to the order $(p-1)$. It follows therefore that $\triangle^{p-1} u_s$ is constant or very nearly so, except perhaps for a periodic part whose period is t. The periodic part when it exists, would also occur in u_s and its differences the period being the same. All differences of W_r, but not W_r itself, will, however, be free from this periodicity.

Taking the commonest form of a periodic series, let us suppose that u_s contains terms like

$$a_s \begin{matrix}\sin \\ \cos\end{matrix} \left(\frac{2\pi ms}{t} \right),$$

where m is an integer. We have from (129), in accordance to our supposition,

$$\triangle^{p-1} u_{s+t} = \triangle^{p-1} u_s,$$

and so, $\triangle^{p-1} a_{s+t} = \triangle^{p-1} a_s.$

Since a_s is non-periodic we can put

$$a_s = c_0 + c_1 s + c_2 s^2 + \dots + c_{p-1} s^{p-1} = \sum_{\nu=0}^{p-1} c_\nu s^\nu , \qquad (130)$$

so that the above condition may be satisfied. The periodic part of W_r is then

$$\sum_{s=r}^{r+t-1} a_s \begin{matrix}\sin \\ \cos\end{matrix} \left(\frac{2\pi ms}{t} \right) = \sum_{s=r}^{r+t-1} \sum_{\nu=0}^{p-1} c_\nu s^\nu \begin{matrix}\sin \\ \cos\end{matrix} \left(\frac{2\pi ms}{t} \right),$$

$$\text{or,}\ \sum_{\nu=1}^{p-1} c_r \sum_{s=r}^{r+t-1} s^\nu \begin{matrix}\sin\\ \cos\end{matrix}\left(\frac{2\pi ms}{t}\right), \tag{131}$$

since the first term for $\nu=0$ is zero. It can be seen that the coefficients of c_1 and c_2 are respectively

$$\mp \tfrac{1}{2} t \begin{matrix}\cos\\ \sin\end{matrix} \frac{\pi(2r-1)m}{t} \operatorname{cosec}\frac{\pi m}{t};$$

and,

$$\mp \frac{t(2r+t-1)}{2} \begin{matrix}\cos\\ \sin\end{matrix} \frac{\pi(2r-1)m}{t} \operatorname{cosec}\frac{\pi m}{t}$$

$$+ \frac{t}{2} \begin{matrix}\sin\\ \cos\end{matrix} \frac{\pi(2r-1)m}{t} \operatorname{cosec}\frac{\pi m}{t} \cot\frac{\pi m}{t},$$

the upper signs and symbols are to be taken together, and the lower ones together.

The problem set before us, however, at the beginning of this article is not concerned with periodic parts. We shall therefore neglect the question of periodicity in the subseqent discussion of the problem. Hence we put

$$u_s = B_0 + B_1 \binom{s}{1} + B_2 \binom{s}{2} + \ldots + B_{p-1}\binom{s}{p-1}, \tag{132}$$

the B's being constants. This relation will be approximate instead of exact if $\Delta^p u_s$ is very small instead of being zero. We shall however proceed with the assumption that (132) is exact, it being understood that if in any case (132) is to be approximate all the subsequent results are approximate too.

Substitute the assumed values of u's in (127) and sum up $\Sigma \binom{s}{r}$; we then get

$$W_s = B_0 t + B_1 \left\{\binom{s+t}{2} - \binom{s}{2}\right\} + B_2\left\{\binom{s+t}{3} - \binom{s}{3}\right\} + \ldots + B_{p-1}\left\{\binom{s+t}{p} - \binom{s}{p}\right\}, \tag{133}$$

where $s=0, 1, 2, \ldots m$. Whence

$$\Delta W_s = B_1\left\{\binom{s+t}{1} - \binom{s}{1}\right\} + B_2\left\{\binom{s+t}{2} - \binom{s}{2}\right\} + \ldots + B_{p-1}\left\{\binom{s+t}{p-1} - \binom{s}{p-1}\right\}, \tag{134}$$

$$\Delta^2 W_s = B_2\left\{\binom{s+t}{1} - \binom{s}{1}\right\} + \ldots + B_{p-1}\left\{\binom{s+t}{p-2} - \binom{s}{p-2}\right\}, \tag{135}$$

etc. Finally,

$$\triangle^{p-1}W_s = B_{p-1}\left\{\binom{s+t}{1}-\binom{s}{1}\right\} = B_{p-1}\,t\,. \tag{136}$$

We thus get p linear equations which will lead to unique set of values of B_{p-1}, B_{p-2}, . . . , B_1 B_0. Substitute these values in (132) and we get u_s in terms of W_s and its differences.

If we put $s=0$ in (133) to (136) before solving the equations, we get the constants, B's, in terms of W_0 and its differences,—our desired result.

I have calculated the constants for $p=4$. The results in this case are

$$u_s = \frac{1}{t}\left[W_s - \frac{t-1}{2}\triangle W_s + \frac{t^2-1}{12}\triangle^2 W_s - \frac{t^2-1}{24}\triangle^3 W_s\right] \quad . \quad . \quad . \quad . \tag{137}$$

and

$$u_s = \frac{1}{t}\Big[W_0 + \tfrac{1}{2}(2s-t+1)\triangle W_0 + \tfrac{1}{12}(6s^2-6st+t^2-1) \times \triangle^2 W_0 + \frac{1}{24}\left\{(4s^3-6s^2-1)-6s(s-1)t+(2s-1)t^2\right\} \times \triangle^3 W_0\Big] \;. \tag{138}$$

One noteworthy feature of (137) is that the coefficients involved are independent of s.

As we had observed before, $\frac{W_s}{t}$ is the moving average of the u's taken t at a time. And the manner of determination of the B's is equivalent to the finding of a parabola of $(p-1)$-th degree passing through the given points (s, W_s), though not the best-fitting parabola for the given u's. And the subsequent formula for u_s is obtained with the help of this parabola. The formulas (137) and (138), and similar ones that can be derived in this manner, can therefore be regarded as graduation-formulas for u's. The formula (137) gives u_s in terms of u_s , u_{s+1}, u_{s+2}, . . . ; and the formula (138) may be made to give u_s in terms of u_s , u_{s-1}, u_{s+1}, u_{s-2}, u_{s+2}, . . . by properly choosing s.

(Concluded)

RAJARAM COLLEGE,
KOLHAPUR

CELLULAR CLOUDS

By

DR. M. W. CHIPLONKAR

INTRODUCTION

IN recent years the subject of clouds has attracted the attention of a number of workers and numerous papers have appeared dealing particularly with the patterns produced in natural as well as artificial clouds. Besides the earlier works of W. Peppler, W. Kopp, C.J.P. Cave (5), Captain Douglas, G.A. Clarke (4) and others the more recent work of C. E. Deppermann (14) and the present author (16) may be cited as typical examples of studies of natural clouds. On the other hand S. Mal (8), G. T. Walker and A. Phillips (9), A. Graham (10), Ramanathan and V.N. Kelkar (12), and Krishna Chandra (15) have carried out detailed laboratory study of patterns produced by thermal instability, with and without a shear superposed upon it, in shallow layers of fluids. It may be remarked here that of the two main varieties of natural clouds, *viz.*, the heap clouds (the cumulus clouds) and the layer clouds (the stratiform clouds) it is the latter variety which is better suited to produce the most vivid and extremely elegant patterns in the sky, with which we are mainly concerned here. These cloud patterns often resemble waves on the surface of water or on a sandy beach, or appear like rolls of spun cotton ; at times they resemble thickly packed balls of cotton, large or small, or present the appearance of a huge flock of sheep. Contrary to the early explanations put forward by Helmholtz and Lord Kelvin to explain the formations, especially of the wave-like patterns, H. Benard (1) and later P. Idrac (3) and T. Terada (7) suggested from their laboratory experiments that they might be due to the same cause that gives rise to the convection cells (now known as the Benard Cells) in shallow unstable layer of a fluid. [This sort of movement was also observed long before by Weber in very thin films of liquid mixtures on a microscope slide and by James Thomson in deeper layers of soapy solutions in an open tub.] The experimental work of later investigators on instability layers, referred to above, has not only supported their suggestion but has further elucidated many other points of detail demanded by the theory first developed by Lord Rayleigh (2) and later modified by Harold Jeffereys(6).

In the previous paper, referred to above, the author has carried out a systematic photographic study of natural clouds, mainly with a view to follow the changes in their forms and arrangements. In order, however, to bring out as clearly as possible the complete resemblance between the natural and the artificial cloud patterns the author has further selected out, and reproduced here, from his collection of cloud photographs only, a few typical ones and compared them with those of the artificial cloud patterns already obtained in the laboratory by K. Chandra.

For the purpose in hand the numerous photographs of natural clouds have been grouped into the following three groups :—

(1) Those showing irregular polygonal cells.

(2) Those showing long rolls (with or without polygonal cells).

(3) Those showing polygonal cells arranged in rows.

First Group—Irregular Polygonal Cells :

The photograph shown in Figure 1 (*a*) was taken of an overhead alto-cumulus cloud at about 11 a.m., on the 10th April 1939. There was no movement of the cloud as a whole in any direction but the sheet of uniform cloud originally formed as a thin layer was seen to break up into different, irregularly set, polygonal cells [shown separately in the trace in Figure 1 (*b*)] and at the same time to grow thicker. The internal movements in this type of cloud did not produce any wholesale changes in the pattern except the strengthening or weakening of some of the lines and foci of descent. This cloud, once formed, was quite stable and lasted for about an hour or so. Figure 1 (*c*) shows the photograph of an unstable layer of air mixed with smoke. Here also no bodily movement existed but the dark centres and lines were seen to appear and disappear slowly. The resemblance between Figures 1 (*a*) and 1 (*c*) is remarkable.

Figure 2 (*a*) is also a photograph of an overhead alto-cumulus cloud taken on a fairly clear day in October 1940. In this the polygonal cells are much smaller in size and are more clearly defined. There was very little movement of the cloud as a whole, but it evaporated away soon. A few of these polygonal cells are shown separately by tracing their outline in figure 2 (*b*). Figure 2 (*c*) shows the corresponding type of cellular structure observed in a shallow layer (7 mm. deep) with a large difference of temperature (130°C) between the top and bottom layers. Here also the resemblance between the two pictures is striking.

The movement of the fluid in such a cell, the normal Benard Cell, is that of an ascent in the centre, a flow outwards from the centre in the

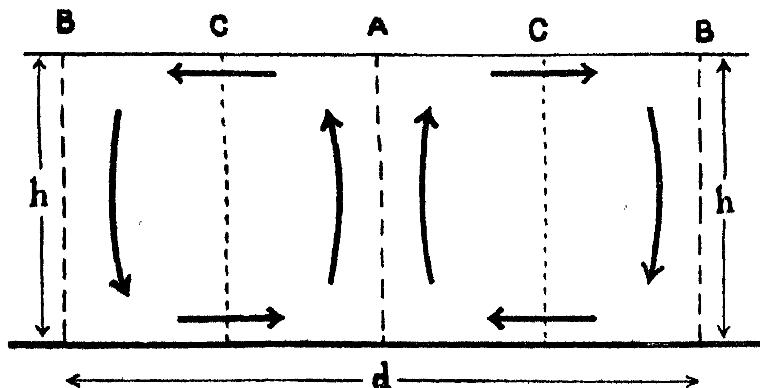


FIG. 3— Circulation of Fluid in a Normal Benard Cell.

uppermost layer, a descent all along the periphery and finally a flow inwards to the centre in the lowest layers of the cell (see Figure 3). The white cloud material which may be existing already or which may be formed by fresh condensation above the ascending currents is collected at such places as C, C, while at A is formed the dark (blue sky in nature) centre and at places such as B, B, is formed the dark (blue sky in nature) boundary of the cells. When the supply of the cloud material is abundant the portions C, C, join up and then the dark centre A is not visible. A circulation in the reverse direction is also possible and is, in fact, often noticed in nature, *i.e.*, the ascent is all along the periphery and descent at the centre of the cell. Obviously such a process will produce a pattern complimentary to that of the normal Benard Cell, *i.e.*, a network of filaments of white cloud material with empty, circular, dark patches in the centre. A very simple but interesting question might be raised here regarding the two motions. Are they not one and the same thing? The normal type of motion being as shown in Figure 3 and the reverse type as that when the same Figure is inverted or seen upside down? Hydrodynamically the two motions represent the two solutions of the same problem and are identical except for a change of sign. Both solutions must be equally applicable but in practice when working with an unstable layer of a liquid it is found that the liquid always rises in the centre of the cell whether we heat it at the bottom or cool it at the top (normal type), and with air it always descends in the centre (the reverse type). This point was carefully studied by Graham and explanation was put forward for the difference by distinguishing the initial type of motion from the final steady viscous motion. An elaborate argument, into which we need not go here, has been given by Sir G. T. Walker in his article in *Science Progress* (11), pages 390-391, to which the readers are referred. The point to note here is that the two types of motion when they occur in the atmosphere produce two distinct varieties of cloud patterns depending upon the prevalent conditions of temperature, lapse rate, humidity, *etc.*, in that layer. Figure 4(*a*) [and 4(*b*)] is an example of such a 'Reticular' cloud in nature, Figure 4(*c*) being its imitation in the laboratory. It presents the queer appearance of a sheet of paper punched irregularly by circular holes.

Second Group—Long Rolls with or without Polygonal Cells :

Coming to the second group of photographs we see that they include two distinct types of roll structures : (*a*) transverse or wavy rolls and (*b*) longitudinal or straight long rolls.

(*a*) *Transverse or Wavy Rolls*—

Figure 5 (*a*) shows the photograph of a very low alto-cumulus roll cloud taken on the 12th April 1939, with the camera facing the zenith sky. The cloud bank was observed to move as a whole in the direction shown by the arrow in the tracing in Figure 5 (*b*) with the rolls at right angles to it. The front lines of the rolls are very sharply defined and each roll shows in itself a superposed structure of round cells. The

similarity with the corresponding laboratory pattern, Figure 5(*c*), which was developed in a 12 mm. layer of air, with a temperature difference of 95°C between the top and bottom and with a small shear movement from the left to the right is perfect. An extremely beautiful photograph of a wavy or transverse alto-cumulus cloud is shown in Figure 6 (*a*). It will be seen from the tracing in Figure 6 (*b*) that the various points of break in different rolls lie on straight lines parallel to the direction of shear; and this may be regarded as an indication of the tendency to form a cross-pattern, described later on, or longitudinal rolls in the same sheet of clouds.

An interesting example of transverse rolls and polygonal cells in the same sheet of alto-cumulus cloud is shown in Figure 7(*a*). This is one of the series of photographs taken on the morning of 19th July 1939, with the camera almost facing the zenith sky. The sequence of movements showed that the cloud material of the freshly formed cellular pattern was gradually being moulded into transverse roll structure due to a small shearing motion at the cloud level. The direction of motion of the cloud marked by the arrow in Figure 7(*b*) is more or less normal to the length of the rolls produced. The laboratory pattern obtained under similar conditions (*i.e.*, the superposition of a small amount of shear on the already existing polygonal structure, depth=8 mms., difference of temperature=100°C at the top and bottom, and shear=2.5 cm. sec. approximately) is seen in Figure 7(*c*).

(*b*) *Longitudinal or Straight, Long Rolls*—

Perhaps the only convincing photograph of a longitudinal straight roll cloud that was obtained by the author till now is reproduced in Figure 8(*a*). It is the photograph of the spread-out portion of a large anvil of a cumulo-nimbus cloud. It was exposed late in the evening of 30th March 1939. The rolls marked by the flow lines in the trace in figure 8(*b*) were actually seen to develop when the cloud was overhead, but at that time the lower scuds did not allow a complete view of those rolls from below. The photographs could therefore be taken only after about 40 minutes (!) when the scuds moved away. The anvil had also moved sideways during that time and presented a more or less profile view. When overhead the rolls had a close resemblance to the pattern in Figure 8(*c*) obtained in the laboratory in a 16 mms. layer of air with a small difference of temperature between the top and bottom (29°C) and a large amount of shear (10 cms. per second).* Occasionally it is found that such rolls have sinusoidal or wavy boundaries and are bent at the ends [Figures 9 (*a*) and 9(*b*)], perhaps due to the shearing motion falling below a certain value while the convection due to thermal instability still retaining the same original strength. The laboratory pattern in Figure 9(*c*) which resembles this picture most is obtained while working with a layer of air

**Note*:—Long, straight roll clouds are very rare, and in the opinion of the author, the photograph taken by G. A. Clarke (which is often reproduced by others) is perhaps the only convincing example of its kind in the whole literature.

16 mms. deep, a large difference of temperature and a comparatively small amount of shear from 5 to 8 cms. per second.

Third Group—Polygonal Cells Arranged in Rows :

In this group of photographs we see that the cloudlets are arranged generally in two sets of parallel lines and depending on the angle between these two sets of parallels depends the shape of each cloudlet, *e.g.*, rectangular or rhombic.

An example of such a pattern of rectangular cloudlets is given in Figures 10(*a*) and 10(*b*) which was obtained in the evening on 18th July 1939, with the camera pointing towards the western sky, at an altitude of 50°. The cloud was gradually evaporating away. Such a pattern has been shown to be produced when on the thermal instability is superposed an intermediate amount of shear. This has been found to be rather difficult to attain while working in the laboratory. The cloudlets arrange themselves in rows which are parallel and perpendicular to the direction of shear or at an angle of about 45° to that direction. The laboratory product which compares very well with this is shown in Figure 10(*c*) which is due to A. Graham and is reproduced here from Sir G. T. Walker's article in *Science Progress* (11). Here also the resemblance between the natural and artificial cloud patterns is almost perfect.

The cellular structure associated with large cumulus clouds has recently attracted the attention of the aviators. A very good example of such cellular cumulus clouds arranged in line is shown in Figures 11(*a*) and 11(*b*). Advantage is taken by the pilots of gliders of the ascending movement of air under each cumulus in such a row of clouds to go over long distances. When below the cloud the glider gains in height and when between two such clouds it gains horizontal distance but loses its height. Thus the glider goes hopping from one cloud (or centre of the convection cell) to another cloud. Hence they are very aptly described as cloud streets !

CONCLUSION

In conclusion it may be said that the above comparisons prove beyond doubt that qualitatively, and to some extent quantitatively also, the two processes are identical. It should however be remembered that although a few investigators have made quantitative measurements on the physical conditions existing in and around the natural clouds, much quantitative data, especially regarding the actual sizes of the cells formed in the atmosphere, is yet necessary before the final word is said regarding the subject.

The author has great pleasure in expressing his indebtedness to Mr. K. Chandra for kindly allowing the author to use his artificial cloud photographs in this paper.

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SIR PARASHURAMBHAU
COLLEGE, POONA

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FIG. 1 (*a*)

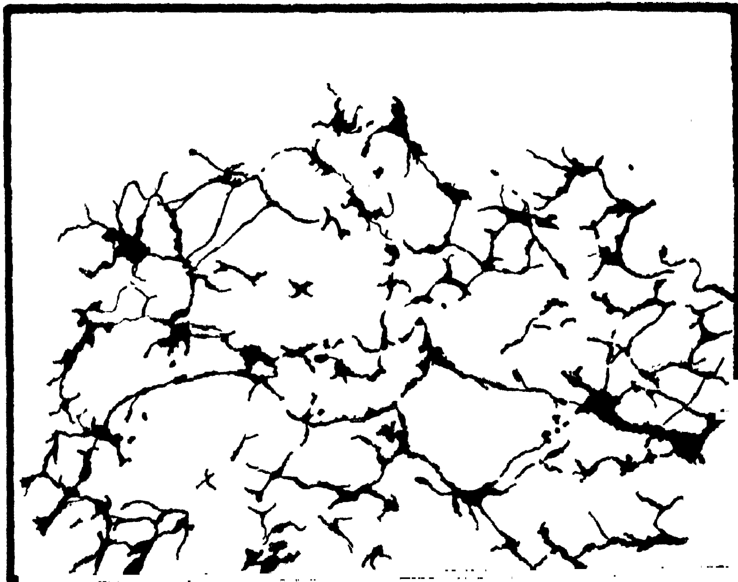


FIG. 1 (*b*)

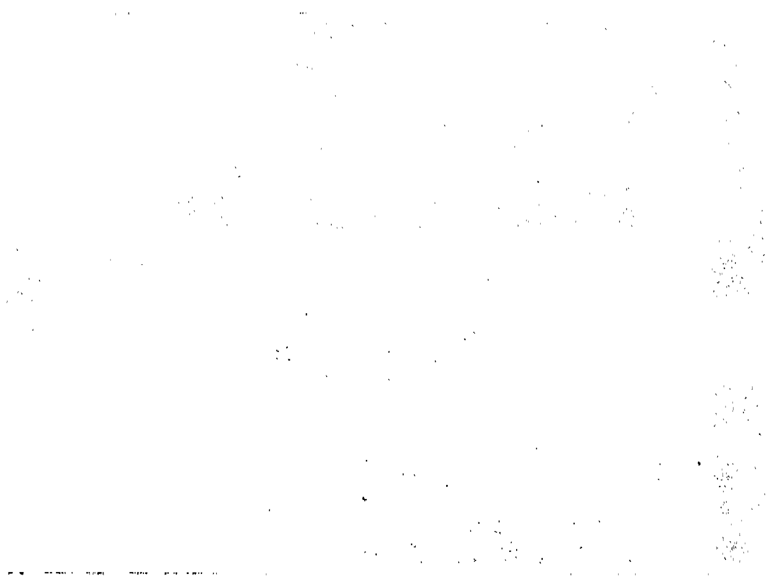


FIG. 1 (*c*)



FIG. 2 (*a*)

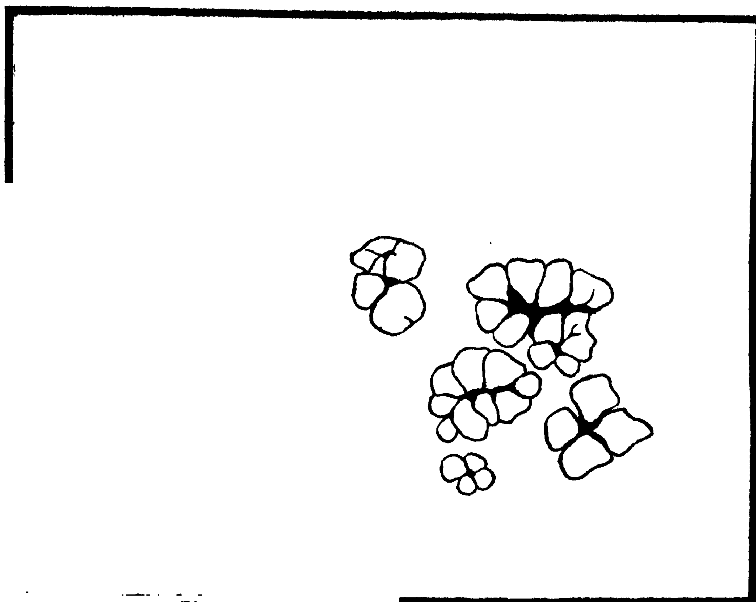


FIG. 2 (*b*)

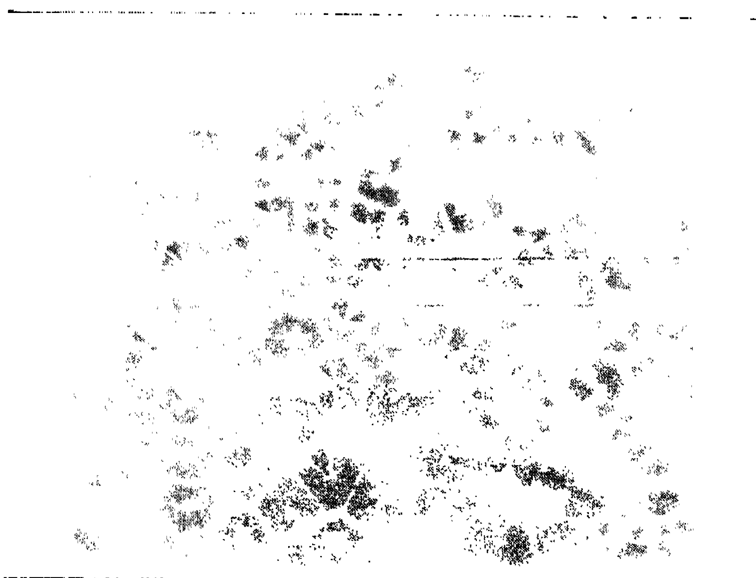


FIG. 2 (*c*)

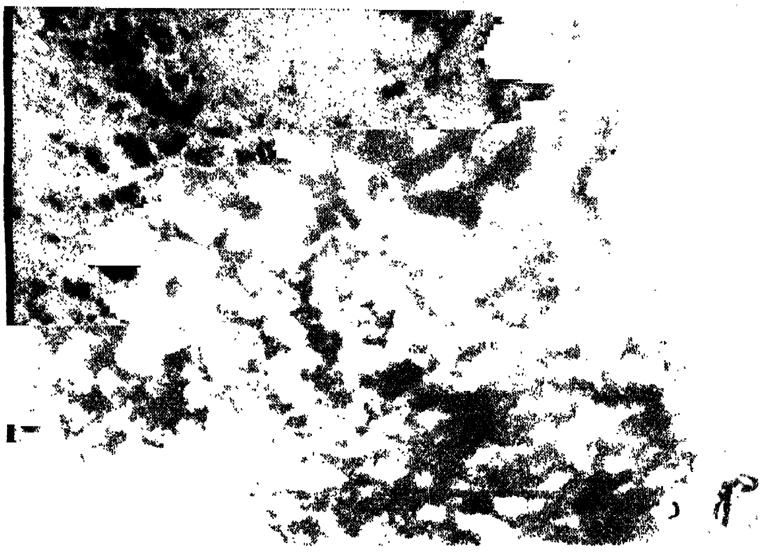


Fig. 4 (*a*)

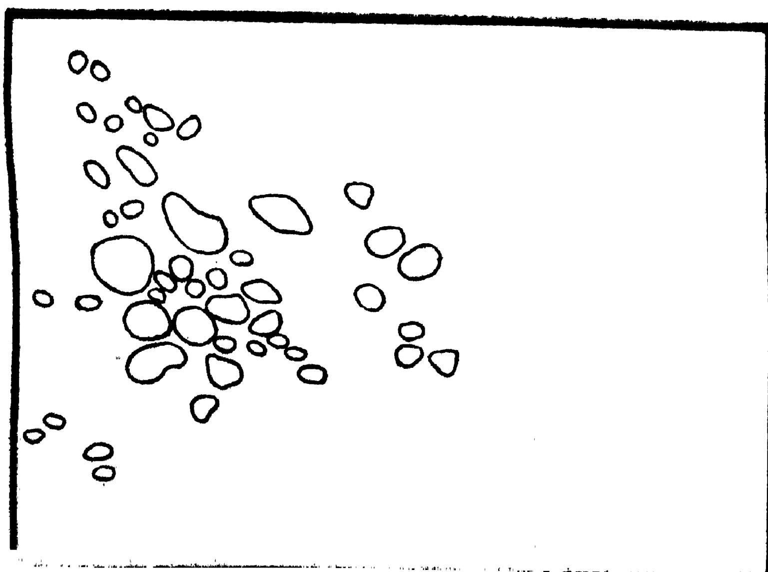


Fig. 4 (*b*)

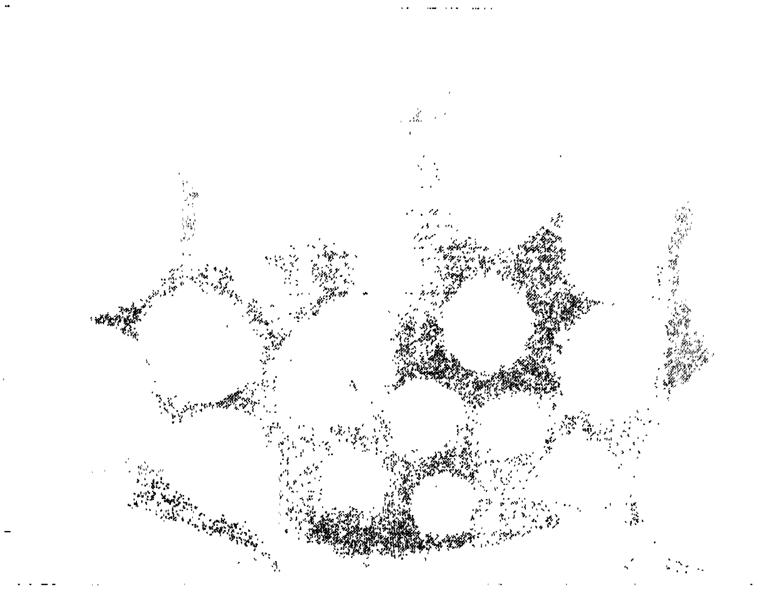


FIG. 4 (c)



FIG. 5 (a)



FIG. 5 (*b*)



FIG. 5 (*c*)

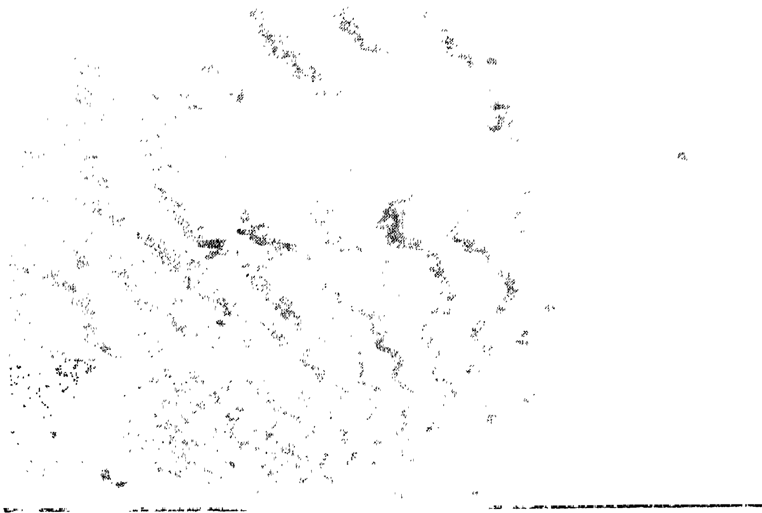


Fig. 6 (*a*)

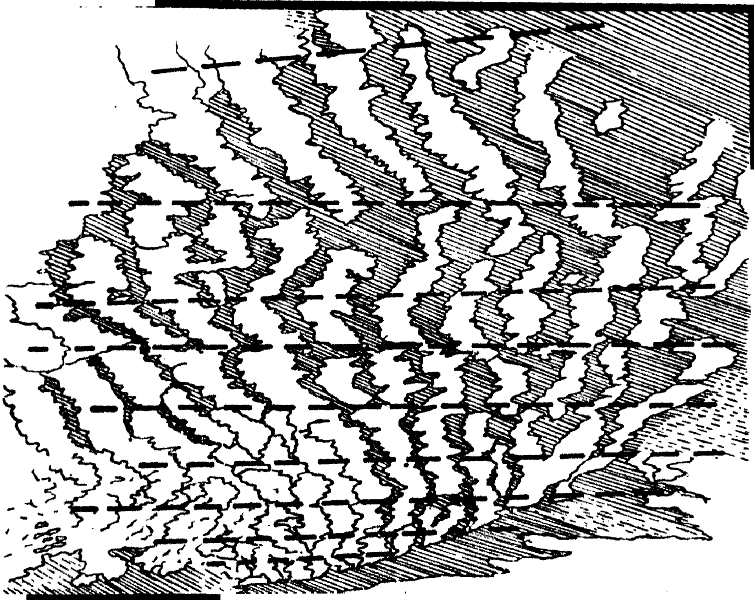


Fig. 6 (*b*)



Fig. 7 (*a*)

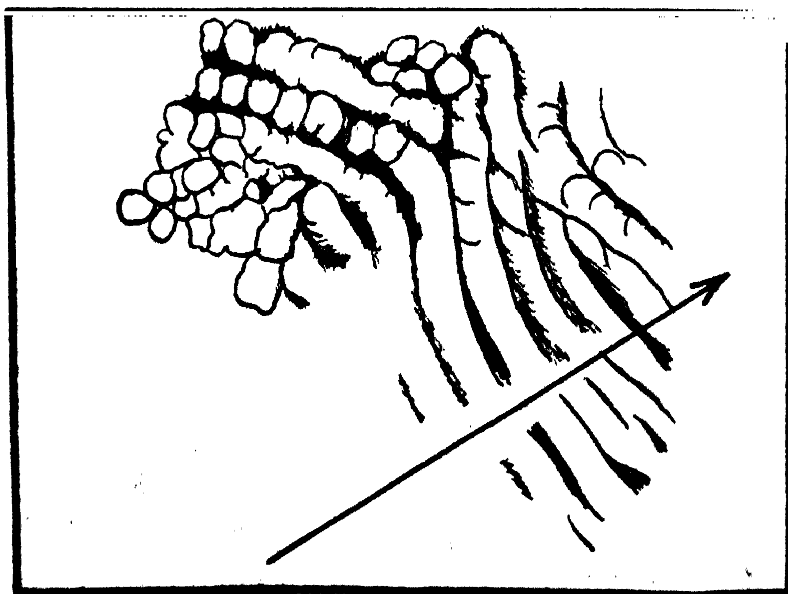


Fig. 7 (*b*)

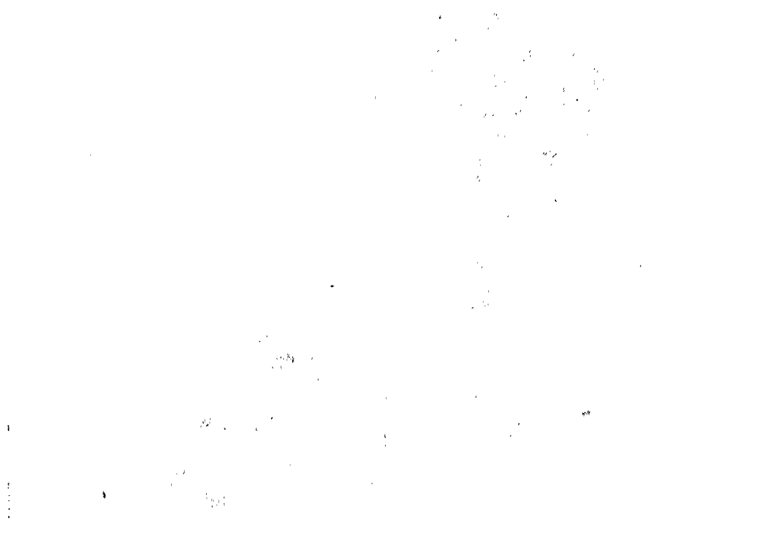


Fig. 7 (*c*)

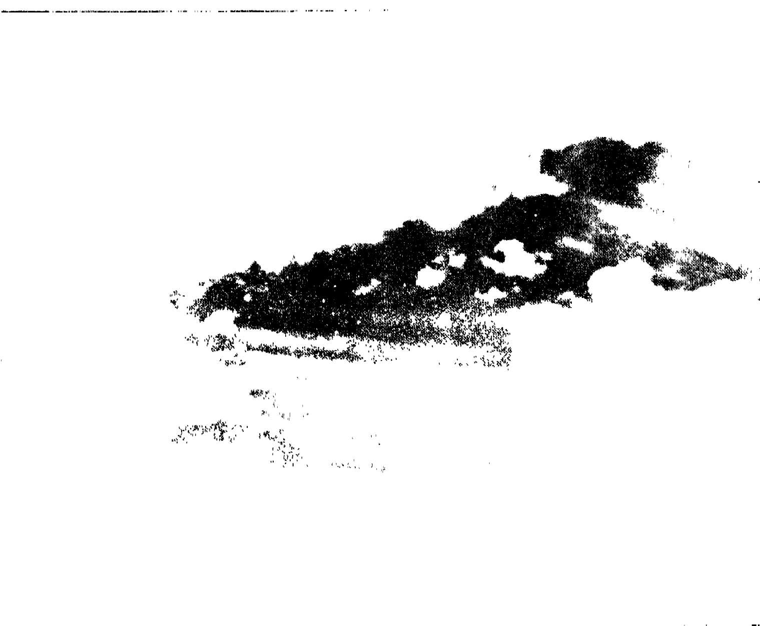


Fig. 8 (*a*)

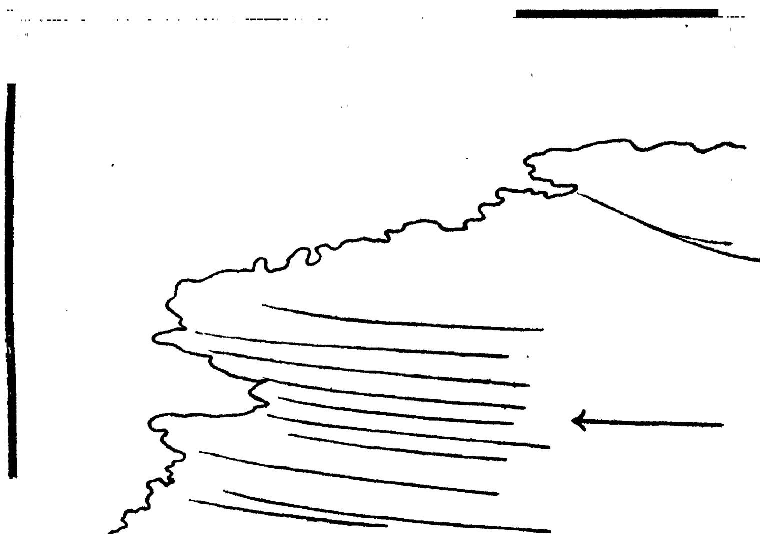


Fig. 8 (*b*)

Fig. 8 (*c*)



FIG. 9 (*a*)



FIG. 9 (*b*)

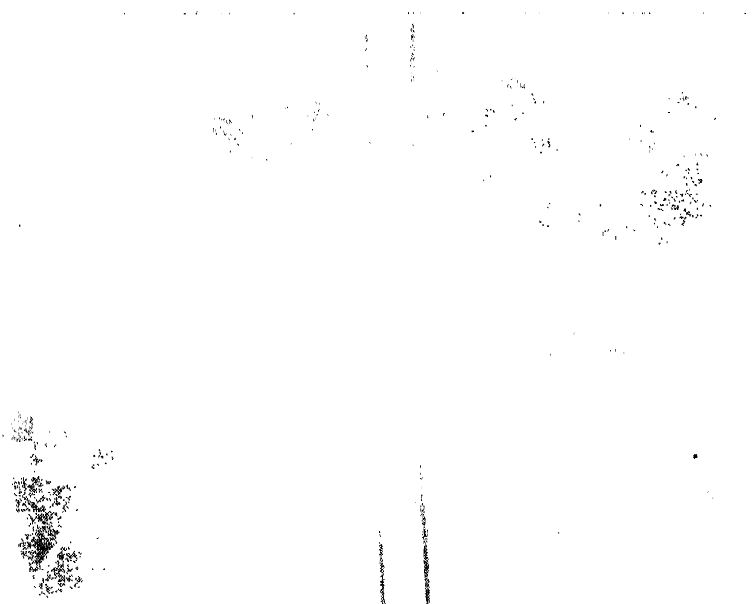


FIG. 9 (*c*)

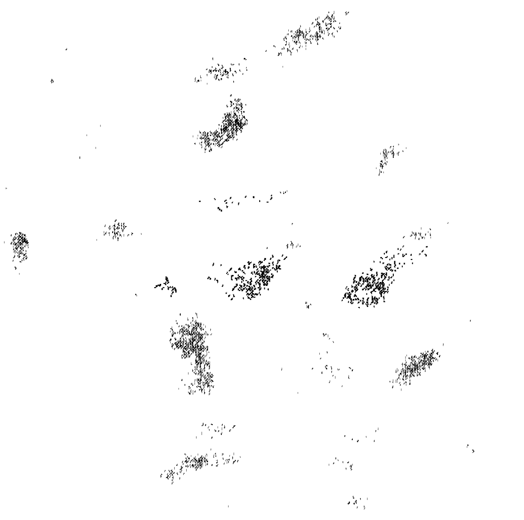


FIG. 10 (*a*)

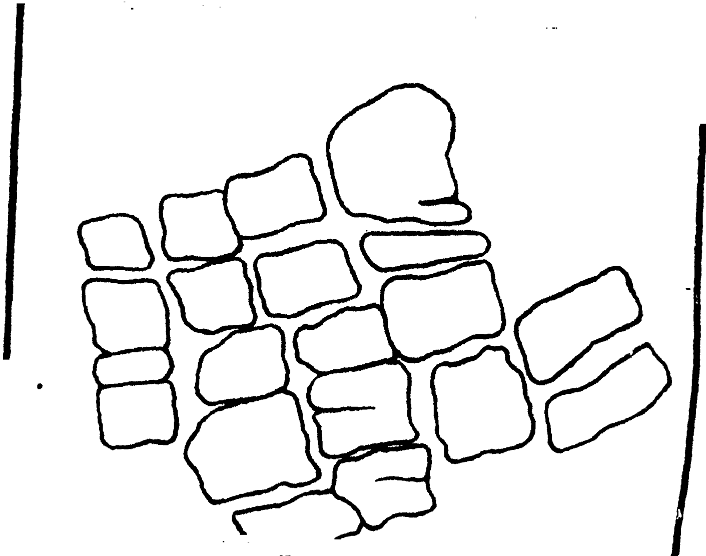


FIG. 10 (*b*)

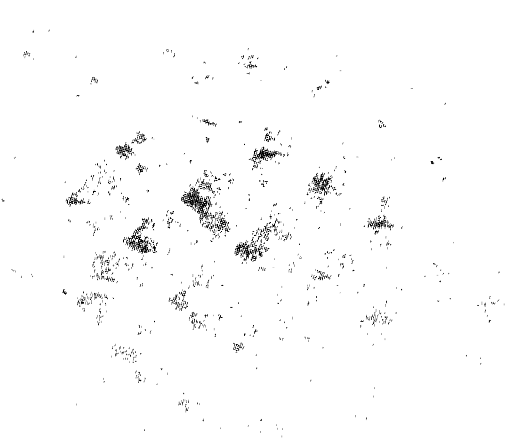


FIG. 10 (*c*)

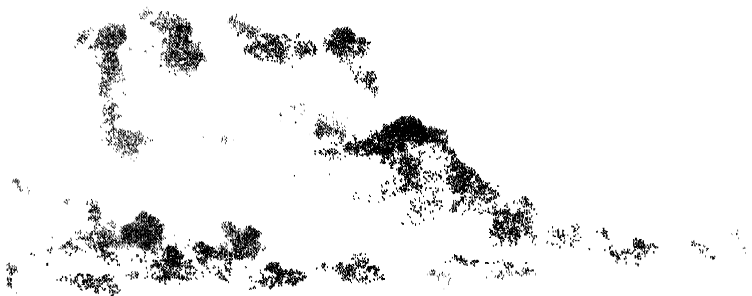


FIG. 11 (*a*)

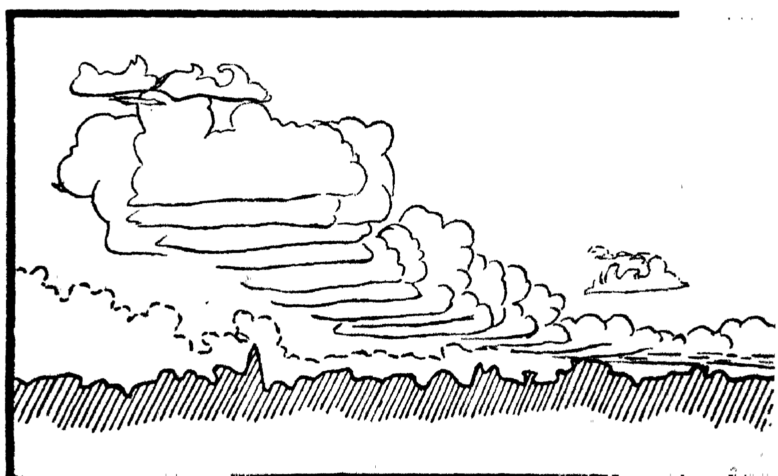


FIG. 11 (*b*)

SYNTHETIC PRODUCTION OF CAMPHOR FROM PINENE—PART V

By

B. G. S. Acharya

As a result of a systematic investigation on the production of camphor from Pinene only two processes out of very many claimed both by the academic and patent literature have been recommended which show promise of success on the industrial scale. (Acharya and Wheeler, this Journal, Vol III, Part II, Sept. 1934, 163). In part II (Acharya and Wheeler, this Journal, Vol. IV, Part II, Sept. 1935, 118), the improvements in the yields for various stages in the synthesis were described. Besides, the recovery of reagents used was also discussed. Part III and Part IV (Acharya *et al.*, this Journal, Vol. X, Part 5, Nov. 1942, 106 ; this Journal Vol. XI, Part 5, Nov. 1943, 113), dealt with borneol, isoborneol and their esters and the oxidation of borneols to camphor respectively.

Camphene is an important intermediate in the production of camphor as it can be directly oxidised to camphor. Hence it was thought important to improve the yield of camphene from Pinene hydrochloride or cheapen the process in its production. In part II (*loc. cit.*), crude cresol was used. The feasible methods suggested have been subjected to a thorough and systematic examination with many modifications and a satisfactory yield (90%) has *now* been obtained using dry sodium stearate in conjunction with caustic soda and washing soda. The patent literature usually claims quantitative yield. But up to now I have not been successful. Attempts made to use lime in view of its cheapness were not successful.

The present work consists in the use of dry soap in conjunction with caustic soda and washing soda. Sodium stearate is prepared from stearic acid and caustic soda and is freed from moisture. A mixture of Pinene hydrochloride (1 mol.), dry soap (2 mols.), sodium carbonate (1 mol.) and caustic soda (1 mol.) is heated under reflux for 24 hours. The whole thing is then distilled and is then washed with water. The camphene thus obtained (semi-solid) can be used for converting it into camphor without further purification. Yield : 90% of the theoretical (with cresol it was 86% of the theoretical). A slight increase in the yield as previously reported (*loc. cit.*), *viz.*, 2 to 3% can be obtained by carrying out the distillation under reduced pressure and conducting the reaction in an atmosphere of nitrogen.

The residue left after the distillation can be re-used with fresh additions of 1 mol. of soap and 1 mol. each of sodium carbonate and caustic soda for every mol. of Pinene hydrochloride. After using the same residue 10 times with additions as stated above, there is a tendency for a decrease in the yield of camphene. Hence it is advisable to use fresh dry

soap after making use of the residue 8 to 9 times. This is due to the accumulation of sodium chloride in the reaction mixture which has no part in the conversion. This was shown to be the case by removing the sodium chloride formed by treatment of the residue with water, drying and using the remaining soap which proved to be as effective as the dry soap.

In place of stearic acid, other vegetable and animal oils and fats were tried. Of the vegetable oils used Mowda oil appears to be the best, probably on account of its high stearin content. Ground-nut oil appears to be least effective, probably for its high oleic content. Mutton tallow should give the maximum yield taking stearin content as the criterion. It gave only 87% of the theoretical and the resulting camphene, however, solidifies into a waxy solid quicker.

The following table gives at a glance the yield of camphene obtained by treatment of Pinene hydrochloride with soaps from various oils. To know the purity of camphene obtained it was oxidised in each case as described in Part II (*loc. cit.*), and is also included in the table. The results agree well with that obtained from camphene prepared by the cresoxide or phenoxide method (63%).

No.	Soap from	% Yield of Camphene	Remarks	% Yield of Camphor from Camphene
1	Mowda Oil	90	On chilling the product becomes waxy semi-solid	63
2	Coconut Oil	84	,,	62.5
3	Ground-nut Oil	69	,,	62.5
4	Castor Oil	73	,,	62
5	Linseed Oil	71	,,	63
6	Cottonseed Oil	68	,,	63
7	Mutton Tallow	87	The product solidifies quickly	63.5

My best thanks are due to the University of Bombay for a research grant towards the expenses of the chemicals.

DEPARTMENT OF CHEMISTRY,
DHARMENDRASINHJI COLLEGE, RAJKOT,
AND GARUTMAN LABORATORIES,
JACOB CIRCLE, BOMBAY

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FATTY OIL FROM THE FRUIT OF MARTYNIA DIANDRA (N.O. PEDALIACEAE)

By

A. V. Rege, J. W. Airan and S. V. Shah

THE fruit of *Martynia diandra* (English : *Devil's Claw* ; Marathi : *vinchu* ; Hindi : *bichu*) was collected for the present investigation from the immediate neighbourhood of Kolhapur. The fruit has two claws and a tough coating from which the seeds can be separated with great difficulty. Therefore the entire dried fruit was crushed and extracted with carbon tetrachloride in a soxhlet, and the yield of the oil calculated on this basis was found to be 20 per cent. Last traces of the solvent were removed by distillation under vacuum. The oil has an orange tinge but no characteristic odour A Note on this subject appeared previously (Current Science, *11* (7), 291). The physical and chemical constants of the oil are given in Table I.

Table I

Specific gravity at 23°C ..	0.9528	Reichert-Meissel value	3.88
Refractive index at 23°C ..	1.4720	Polenske number	0.78
Acid number	15.42	Acetyl value	10.79
Saponification value	195.3	Unsaponifiable matter	0.86 Per cent.
Iodine value	75.62		

Insoluble Mixed Fatty Acids—

The oil was saponified with alcoholic potash and the soaps formed were washed with ether to remove the unsaponifiable matter, and decomposed by hydrochloric acid. The mixed fatty acids thus liberated were washed with hot water and finally filtered through a hot water funnel. The constants of these total mixed acids are given in Table II.

Table II

	Per cent.		Per cent.
Yield	96.5	Acid number	208.4
Iodine value	78.63	Hence, mean molecular weight ..	268.7

According to this iodine value for total mixed fatty acids, the iodine value for the oil would be 75.88, which corresponds well with the one actually obtained, namely, 75.62.

The saturated fatty acids were separated from the unsaturated ones by Twitchell's lead-salt method (J. Ind. Eng. Chem., *1921*, 806). 29 g. of the total mixed fatty acids gave 5.5 g. (*i.e.*, 18.97 per cent.) saturated fatty acids, and 23.4 g. (*i.e.*, 80.69 per cent.) unsaturated fatty acids.

Solid Fatty Acids—

The lead salts of the saturated fatty acids were decomposed with dilute nitric acid and the liberated acids were taken up with ether and washed with water till the washings were no longer acid to methyl orange. The solid fatty acids thus obtained on the evaporation of the ether gave the following constants :

TABLE III

	Per cent.		Per cent.
Iodine value	2.0	Hence, mean molecular weight ..	270.4
Acid number	207.1	Melting point	55 to 56°C

These solid acids were then converted into their methyl esters by refluxing them with methyl alcohol in the presence of dry hydrochloric acid in the usual manner. 13.31 of these methyl esters were fractionally distilled under 7—9 mm. pressure when the following fractions were obtained :

TABLE IV

Fraction	Temperature C°	Weight g.	S.V.	Mean Molecular Weight
I	Below 195	1.485	206.7	271.0
II	195-200	2.0301	199.3	280.9
III	200-205	1.697	197.7	283.2
IV	205-210	1.131	197.2	284.0
V	210-220	6.9366	196.6	284.8

Each of the above fractions was separately hydrolysed and the acids obtained were separated by fractional crystallization, when in each case only palmitic and stearic acids (and no other acids) were obtained. These two acids in each case were identified by molecular weight determinations and mixed melting points with authentic samples of the respective acids. On this basis, the calculated proportions of the methyl esters of these acids in these fractions are as under :

TABLE V

Fraction	Percentages of Methyl Esters of Acids	
	Palmitic	Stearic
I	96.43	3.57
II	61.08	38.92
III	52.86	47.14
IV	50.0	50.0
V	47.14	52.86

This gives a total of 55.3 per cent. of palmitic and 44.7 per cent. of stearic acid, with a mean molecular weight of 268.5 which corresponds well to the one actually obtained, *i.e.*, 270.4.

Liquid Fatty Acids—

The lead salts of the unsaturated fatty acids were decomposed with dilute hydrochloric acid, and the liberated acids were taken up with ether, and washed free from hydrochloric acid. They were then dried over calcium chloride and then the ether was removed by distillation. They gave the following constants :

TABLE VI

	Per cent.		Per cent.
Iodine value	98.68	Hence, mean molecular weight ..	280.6
Acid number	199.6		

According to this iodine value, the iodine value for the total mixed fatty acids should be 79.62, the actual one being 78.63.

Bromination of 22.56 g. of the liquid fatty acids was carried out in ether in the usual manner at the temperature of ice. The reaction mixture was kept in an ice-box overnight. Next day the ether was removed after the complete removal of free bromine by washing with a little dilute solution of sodium thiosulphate, when 36.3g. of total bromine product was obtained. This latter was then rubbed with petroleum ether, when a solid (3.892 g.) separated out. From the filtrate 32.408 g. of liquid bromo-compound was obtained.

The solid bromine product melted at 114°C, and gave a mixed melting point of 114°C with an authentic sample of linolic tetrabromide. Its bromine content was found to be 53.24 per cent., the theoretical amount for linolic tetrabromide being 53.33 per cent. This 3.892 g. of the tetrabromide corresponds to 1.733 g. of linolic acid, which amounts to 7.7 per cent. in the total liquid acids.

The liquid bromo derivative gave 36.20 per cent. bromine content, the theoretical amount for oleic dibromide being 36.18 per cent. The 32.408 g. of oleic dibromide obtained corresponds to 20.67 g. of oleic acid, *i.e.*, 92.3 per cent. in the total liquid acids.

On this percentage basis, the iodine value of the mixed liquid acids works out to be 97.11, whereas the one actually obtained is 98.68.

Hence, the fatty acids obtained are present in the following proportions: Palmitic, 10.49; Stearic, 8.49; Oleic, 74.49; and Linolic, 6.215.

Mr. Rege carried out the experimental part of this work. One of us (S.V.S.) thanks the University of Bombay for a research grant in connection with this work.

RAJARAM COLLEGE,
KOLHAPUR

[*Received : November 17, 1943*]

SYNTHETICAL ANTHELMINTICS—PART IX

α Alkyl γ 4-methoxy-3-tolyl, and α alkyl γ 4-methoxyphenyl butyrolactones

By

S. U. MEHTA, J. J. TRIVEDI, K. V. BOKIL AND K. S. NARGUND

ROSENMOND and Schapiro showed that γ 4-methoxy-3-tolyl butyrolactone and γ 4-methoxy phenyl butyrolactone had each thrice the anthelmintic properties of santonin. (Arch. Pharm. 1934, 272, 313). The effect of introducing an alkyl group in γ position in the above lactones has already been studied by Trivedi and Nargund. (Jou. Bom. Univ. 1941, vol. 10, part 3, 102-105). The present paper deals with similar lactones but having an α alkyl group.

The condensation of alkyl succinic anhydrides with o-cresol methyl ether by Friedel and Craft's reaction gave α alkyl β-4-methoxy-3-toluoyl propionic acids, the constitutions of which were established by oxidation and the formation of pyrilium derivatives. These keto acids on reduction by sodium and alcohol and then lactonisation by dilute

sulphuric acid by the procedure of Trivedi and Nargund (Jour. Bom. Univ. 1941, vol. 10, part 3, 99-101) gave ∝ alkyl γ-4-methoxy-3-tolyl butyrolactones. Similarly the reduction of ∝ alkyl β-4-methoxy benzoyl propionic acids described by Mehta, Bokil and Nargund (Jour. Bom. Univ. 1943, vol. 12, part 3, 64) gave ∝ alkyl γ 4-methoxy phenyl butyrolactones.

EXPERIMENTAL

Alkyl succinic anhydrides were prepared by Mehta, Bokil and Nargund's procedure. The yields of the keto acids obtained by Friedel and Crafts reaction are given below.

Alkyl Succinic Anhydride Used	Keto Acid Obtained	Yield Per Cent
Ethyl succinic anhydride	∝ Ethyl β-4-methoxy-3-toluoyl propionic acid	40
n-Propyl succinic anhydride	∝ n-Propyl β-4-methoxy-3-toluoyl propionic acid	45
n-Amyl succinic anhydride	∝ n-Amyl β-4-methoxy-3-toluoyl propionic acid	30

∝ *Ethyl β-4-methoxy-3-toluoyl propionic acid* :—It was soluble in methyl and ethyl alcohols, acetic acid, benzene and chloroform but insoluble in petrol. It crystallised in short needles when its solution in benzene petrol mixture was cooled in ice. m. p. 99°. On oxidation by sodium hypobromite it gave 4-methoxy-3-toluic acid identified by mixed m. p. with an authentic specimen. It formed a deep red pyrilium derivative with salicyl aldehyde and methyl alcoholic hydrogen chloride. (Found C. 67, 0 ; H, 7.3 per cent. Eqt. wt, 247.4 $C_{14}H_{18}O_4$ requires C, 67.2 ; H, 7.2 per cent. Eqt. wt, 250.) It formed a semicarbazone m. p. 179°. (Found eqt. wt, 299.7. $C_{15}H_{21}O_4N_3$ requires eqt. wt, 307.)

∝ *N-Propyl β-4-methoxy-3-toluoyl propionic acid* :—It was soluble in methyl and ethyl alcohols, acetic acid, ethyl acetate and chloroform and sparingly soluble in petrol from which it crystallised in plates m. p. 96-97°. (Found C, 68.0 ; H, 7.7 per cent. Eqt. wt, 261.9. $C_{15}H_{20}O_4$ requires C, 68.2 ; H, 7.5 per cent. eqt. wt, 264.) It formed a semicarbazone m. p. 159°. (Found eqt. wt, 318.5. $C_{16}H_{23}O_4N_3$ requires eqt. wt, 321.)

∝ *N-Amyl β-4-methoxy-3-toluoyl propionic acid* :—It was obtained in a semi-solid condition in Friedel and Crafts reaction. To purify it, it was esterified and the ester distilled. *Ethyl- ∝ -n-amyl β-4-methoxy-3-toluoyl propionate* had b. p. 260-265 at 60mm. D_4^{30} =1.032. N_D^{30} =1.5103 (Found C, 71.0 ; H, 9.0 per cent. $C_{19}H_{28}O_4$ requires C, 71.2 ; H, 8.8 per cent.) On hydrolysis by alkali it gave ∝ n-amyl-β-4-methoxy-3-toluoyl propionic acid which was again a semi-solid mass but solidified when kept in vacuum for some time. m. p. 40-45°. It was soluble in all the common solvents but could not be crystallised from any solvent. It gave, however, correct figures on analysis. (Found C, 70.1 ; G, 8.4 per cent. Eqt. wt, 297, $C_{17}H_{24}O_4$ requires C, 69.9 ; H, 8.2 per cent. Eqt. wt, 292.)

The lactones obtained by reducing the above keto acids as well as the keto acids described by Mehta, Bokil and Nargund *loc. cit.*, are described in tabular form.

Keto Acid Reduced	Lactone Obtained	Properties of the Lactone	Analysis	
			Found	Requires
α-ethyl-β-4-methoxy-3-toluoyl propionic acid	α-ethyl-γ-4-methoxy-3-tolyl butyrolactone	Soluble in alcohol, chloroform, benzene, and hot petrol. Crystallised from petrol in plates m. p. 63-64°	C, 71.7; H, 7.9 Eqt. wt. by back titration, 234.9.	$C_{14}H_{18}O_3$ requires C, 71.8; H, 7.7. Eqt. wt, 234
α-n-propyl-β-4-methoxy-3-toluoyl propionic acid	α-n-propyl γ-4-methoxy-3-tolyl butyrolactone	Soluble in the common solvents except petrol. Crystallised from petrol in plates m.p. 93°	C, 72.5; H, 8.3 Eqt. wt, 250.6	$C_{15}H_{20}O_3$ requires C, 72.6; H, 8.0 Eqt. wt, 248
α-n-amyl-β-4-methoxy-3-toluoyl propionic acid	α-n-amyl-γ-4-methoxy-3- tolyl butyrolactone	b. p. 258 at 28 mm. m.p. 38-39°. sol in all the common solvents	C, 74.1; H, 8.6 Eqt. wt, 269.8	$C_{17}H_{24}O_3$ requires C, 73.9; H, 8.7 Eqt. wt, 276
α-ethyl-β-4-methoxy-benzoyl propionic acid	α-ethyl-γ-4-methoxy-phenyl butyrolactone	Crystallised in plates from methyl alcohol. m.p. 91-92°	C, 70.7; H, 7.4 Eqt. wt, 216	$C_{13}H_{16}O_3$ requires C, 70.9; H, 7.3 Eqt. wt, 220
α-n-propyl-β-4-methoxy-benzoyl propionic acid.	α-n-propyl-γ-4-methoxy-phenyl butyrolactone	Shining plates from alcohol m.p. 98-99°	C, 71.6; H, 7.8 Eqt. wt, 231	$C_{14}H_{18}O_3$ requires C, 71.8; H, 7.7 Eqt. wt, 234.
αn-amyl-β-4-methoxy-benzoyl zoyl propionic acid	α-n-amyl-γ-4-methoxy-phenyl butyrolactone	Flakes from alcohol m.p. 92°	C, 73.1; H, 8.3 Eqt. wt, 259	$C_{16}H_{22}O_3$ requires C, 73.3; H, 8.4 Eqt. wt, 262
α-n-hexyl-β-4-methoxy-benzoyl propionic acid	α-n-hexyl-γ-4-methoxy-phenyl butyrolactone	Plates from alcohol m.p. 90°	C, 73.8; H, 8.9 Eqt. wt, 271.4	$C_{17}H_{24}O_3$ requires C,73.9; H, 8.7 Eqt. wt, 276
α-n-tetradecyl-β-4-methoxy-benzoyl propionic acid	α-n-tetradecyl-γ-4-methoxyl-phenyl butyrolactone	Plates from alcohol m.p. 79-80°	C, 77.2; H, 10.4 Eqt. wt, 384.6	$C_{25}H_{40}O_3$ requires C, 77.3; H, 10.3 Eqt. wt, 388
α-n-hexadecyl-β-4methoxy-benzoyl propionic acid	α-n-hexadecyl-γ-4-methoxy-phenyl butyrolactone	Crystallised in shining plates from alcohol m.p. 95.96°	C, 77.6; H, 10.7 Eqt. wt, 411.8	$C_{27}H_{44}O_3$ requires C, 77.9; H, 10.6 Eqt. wt, 416

We thank the University of Bombay for a research grant to one of us (K.S.N.) and Charak Trust for some chemicals.

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[*Received: November 24, 1943*]

AGE OF THE DECCAN TRAPS OF THE BOMBAY AND SALSETTE ISLANDS

By

A. S. Kalapesi and R. N. Sukheswala

Introduction

In 1906 Lord Rayleigh(1) demonstrated the widespread distribution of radioactive elements through the rocks of the earth's crust. During the years 1905 and 1906 Lord Rayleigh(2) and Lord Rutherford(3) first saw the bearing of the rate of disintegration of these radioactive substances in the minerals of rocks on the age of the parts of the earth-crust built of them and they thus provided a measure of the age of such minerals and rocks. Then there came in 1907 the researches of Boltwood(4)(5)(6) who made the first attempt to calculate the ages of minerals after the analyses of these minerals for uranium and lead, lead being recognised as the end-product of the uranium-radium series. The extension and supplementing of this work by Joly, Holmes and others, have now enabled us to look to the disintegration of uranium and thorium as the most promising of many methods that have been used in the endeavour to ascertain the age of the earth. Thus the discovery of radioactive property of uranium and thorium, their disintegration at rates, which can be measured, into the end-products isotopic with lead, and the association and accumulation of helium in minerals and rocks containing uranium and thorium have suggested new methods for estimating the earth's age.

The present paper aims at the determination of the geological age of the Deccan Traps of Bombay and Salsette Islands from the actual analyses of the radioactive elements, uranium, thorium and lead contained in them. Chemical methods as applied to the rocks in this paper and given in the Appendix are contrived from the methods of analysis used in the separation of U, Th, and Pb from minerals rich in these constituents.

Occurrence and Distribution

During the long-past history of the earth great floods of lavas have reached intermittently the surface from the depths beneath, covering, in different parts of the world, vast areas of many thousands of square miles. A large part of the Indian Peninsula was affected by a similar stupendous outburst of volcanic energy towards the close of the Cretaceous or the beginning of the Tertiary period. Subsequent to the deposition of the Bagh and the Lameta beds, enormous volumes of lava were extravasated intermittently through fissures and cracks in the crust of the earth. The discharge of lava continued until the previous topography of the country was buried under some 2000 feet (in some places as much as 7000 feet) of lava on an average.

SYNTHETIC PRODUCTION OF CAMPHOR FROM PINENE—PART V

By

B. G. S. ACHARYA

AS a result of a systematic investigation on the production of camphor from Pinene only two processes out of very many claimed both by the academic and patent literature have been recommended which show promise of success on the industrial scale. (Acharya and Wheeler, this Journal, Vol III, Part II, Sept. 1934, 163). In part II (Acharya and Wheeler, this Journal, Vol. IV, Part II, Sept. 1935, 118), the improvements in the yields for various stages in the synthesis were described. Besides, the recovery of reagents used was also discussed. Part III and Part IV (Acharya *et al.*, this Journal, Vol. X, Part 5, Nov. 1942, 106 ; this Journal Vol. XI, Part 5, Nov. 1943, 113), dealt with borneol, isoborneol and their esters and the oxidation of borneols to camphor respectively.

Camphene is an important intermediate in the production of camphor as it can be directly oxidised to camphor. Hence it was thought important to improve the yield of camphene from Pinene hydrochloride or cheapen the process in its production. In part II (*loc. cit.*), crude cresol was used. The feasible methods suggested have been subjected to a thorough and systematic examination with many modifications and a satisfactory yield (90%) has *now* been obtained using dry sodium stearate in conjunction with caustic soda and washing soda. The patent literature usually claims quantitative yield. But up to now I have not been successful. Attempts made to use lime in view of its cheapness were not successful.

The present work consists in the use of dry soap in conjunction with caustic soda and washing soda. Sodium stearate is prepared from stearic acid and caustic soda and is freed from moisture. A mixture of Pinene hydrochloride (1 mol.), dry soap (2 mols.), sodium carbonate (1 mol.) and caustic soda (1 mol.) is heated under reflux for 24 hours. The whole thing is then distilled and is then washed with water. The camphene thus obtained (semi-solid) can be used for converting it into camphor without further purification. Yield : 90% of the theoretical (with cresol it was 86% of the theoretical). A slight increase in the yield as previously reported (*loc. cit.*), *viz.*, 2 to 3% can be obtained by carrying out the distillation under reduced pressure and conducting the reaction in an atmosphere of nitrogen.

The residue left after the distillation can be re-used with fresh additions of 1 mol. of soap and 1 mol. each of sodium carbonate and caustic soda for every mol. of Pinene hydrochloride. After using the same residue 10 times with additions as stated above, there is a tendency for a decrease in the yield of camphene. Hence it is advisable to use fresh dry

soap after making use of the residue 8 to 9 times. This is due to the accumulation of sodium chloride in the reaction mixture which has no part in the conversion. This was shown to be the case by removing the sodium chloride formed by treatment of the residue with water, drying and using the remaining soap which proved to be as effective as the dry soap.

In place of stearic acid, other vegetable and animal oils and fats were tried. Of the vegetable oils used Mowda oil appears to be the best, probably on account of its high stearin content. Ground-nut oil appears to be least effective, probably for its high oleic content. Mutton tallow should give the maximum yield taking stearin content as the criterion. It gave only 87% of the theoretical and the resulting camphene, however, solidifies into a waxy solid quicker.

The following table gives at a glance the yield of camphene obtained by treatment of Pinene hydrochloride with soaps from various oils. To know the purity of camphene obtained it was oxidised in each case as described in Part II (*loc. cit.*), and is also included in the table. The results agree well with that obtained from camphene prepared by the cresoxide or phenoxide method (63%).

No.	Soap from	% Yield of Camphene	Remarks	% Yield of Camphor from Camphene
1	Mowda Oil	90	On chilling the product becomes waxy semi-solid	63
2	Coconut Oil	84	,,	62.5
3	Ground-nut Oil	69	,,	62.5
4	Castor Oil	73	,,	62
5	Linseed Oil	71	,,	63
6	Cottonseed Oil	68	,,	63
7	Mutton Tallow	87	The product solidifies quickly	63.5

My best thanks are due to the University of Bombay for a research grant towards the expenses of the chemicals.

DEPARTMENT OF CHEMISTRY,
DHARMENDRASINHJI COLLEGE, RAJKOT,
AND GARUTMAN LABORATORIES,
JACOB CIRCLE, BOMBAY

[*Received : July 26, 1943*]

FATTY OIL FROM THE FRUIT OF MARTYNIA DIANDRA (N.O. PEDALIACEAE)

By

A. V. Rege, J. W. Airan and S. V. Shah

THE fruit of *Martynia diandra* (English : *Devil's Claw* ; Marathi : *vinchu* ; Hindi : *bichu*) was collected for the present investigation from the immediate neighbourhood of Kolhapur. The fruit has two claws and a tough coating from which the seeds can be separated with great difficulty. Therefore the entire dried fruit was crushed and extracted with carbon tetrachloride in a soxhlet, and the yield of the oil calculated on this basis was found to be 20 per cent. Last traces of the solvent were removed by distillation under vacuum. The oil has an orange tinge but no characteristic odour. A Note on this subject appeared previously (Current Science, *11* (7), 291). The physical and chemical constants of the oil are given in Table I.

TABLE I

Specific gravity at 23°C	0.9528	Reichert-Meissel value	3.88
Refractive index at 23°C	1.4720	Polenske number	0.78
Acid number	15.42	Acetyl value	10.79
Saponification value	195.3	Unsaponifiable matter	0.86 Per cent.
Iodine value	75.62		

Insoluble Mixed Fatty Acids—

The oil was saponified with alcoholic potash and the soaps formed were washed with ether to remove the unsaponifiable matter, and decomposed by hydrochloric acid. The mixed fatty acids thus liberated were washed with hot water and finally filtered through a hot water funnel. The constants of these total mixed acids are given in Table II.

TABLE II

	Per cent.		Per cent.
Yield	96.5	Acid number	208.4
Iodine value	78.63	Hence, mean molecular weight	268.7

According to this iodine value for total mixed fatty acids, the iodine value for the oil would be 75.88, which corresponds well with the one actually obtained, namely, 75.62.

The saturated fatty acids were separated from the unsaturated ones by Twitchell's lead-salt method (J. Ind. Eng. Chem., *1921*, 806). 29 g. of the total mixed fatty acids gave 5.5 g. (*i.e.*, 18.97 per cent.) saturated fatty acids, and 23.4 g. (*i.e.*, 80.69 per cent.) unsaturated fatty acids.

Solid Fatty Acids—

The lead salts of the saturated fatty acids were decomposed with dilute nitric acid and the liberated acids were taken up with ether and washed with water till the washings were no longer acid to methyl orange. The solid fatty acids thus obtained on the evaporation of the ether gave the following constants :

TABLE III

	Per cent.		Per cent.
Iodine value	2.0	Hence, mean molecular weight ..	270.4
Acid number	207.1	Melting point	55 to 56°C

These solid acids were then converted into their methyl esters by refluxing them with methyl alcohol in the presence of dry hydrochloric acid in the usual manner. **13.31** of these methyl esters were fractionally distilled under 7—9 mm. pressure when the following fractions were obtained:

TABLE IV

Fraction	Temperature C°	Weight g.	S.V.	Mean Molecular Weight
I	Below 195	1.485	206.7	271.0
II	195-200	2.0301	199.3	280.9
III	200-205	1.697	197.7	283.2
IV	205-210	1.131	197.2	284.0
V	210-220	6.9366	196.6	284.8

Each of the above fractions was separately hydrolysed and the acids obtained were separated by fractional crystallization, when in each case only palmitic and stearic acids (and no other acids) were obtained. These two acids in each case were identified by molecular weight determinations and mixed melting points with authentic samples of the respective acids. On this basis, the calculated proportions of the methyl esters of these acids in these fractions are as under:

TABLE V

Fraction	Percentages of Methyl Esters of Acids	
	Palmitic	Stearic
I	96.43	3.57
II	61.08	38.92
III	52.86	47.14
IV	50.0	50.0
V	47.14	52.86

This gives a total of 55.3 per cent. of palmitic and 44.7 per cent. of stearic acid, with a mean molecular weight of 268.5 which corresponds well to the one actually obtained, *i.e.*, 270.4.

Liquid Fatty Acids—

The lead salts of the unsaturated fatty acids were decomposed with dilute hydrochloric acid, and the liberated acids were taken up with ether, and washed free from hydrochloric acid. They were then dried over calcium chloride and then the ether was removed by distillation. They gave the following constants:

TABLE VI

	Per cent.		Per cent.
Iodine value	98.68	Hence, mean molecular weight ..	280.6
Acid number	199.6		

According to this iodine value, the iodine value for the total mixed fatty acids should be 79.62, the actual one being 78.63.

Bromination of 22.56 g. of the liquid fatty acids was carried out in ether in the usual manner at the temperature of ice. The reaction mixture was kept in an ice-box overnight. Next day the ether was removed after the complete removal of free bromine by washing with a little dilute solution of sodium thiosulphate, when 36.3g. of total bromine product was obtained. This latter was then rubbed with petroleum ether, when a solid (3.892 g.) separated out. From the filtrate 32.408 g. of liquid bromo-compound was obtained.

The solid bromine product melted at 114°C, and gave a mixed melting point of 114°C with an authentic sample of linolic tetrabromide. Its bromine content was found to be 53.24 per cent., the theoretical amount for linolic tetrabromide being 53.33 per cent. This 3.892 g. of the tetrabromide corresponds to 1.733 g. of linolic acid, which amounts to 7.7 per cent. in the total liquid acids.

The liquid bromo derivative gave 36.20 per cent. bromine content, the theoretical amount for oleic dibromide being 36.18 per cent. The 32.408 g. of oleic dibromide obtained corresponds to 20.67 g. of oleic acid, *i.e.*, 92.3 per cent. in the total liquid acids.

On this percentage basis, the iodine value of the mixed liquid acids works out to be 97.11, whereas the one actually obtained is 98.68.

Hence, the fatty acids obtained are present in the following proportions: Palmitic, 10.49; Stearic, 8.49; Oleic, 74.49; and Linolic, 6.215.

Mr. Rege carried out the experimental part of this work. One of us (S.V.S.) thanks the University of Bombay for a research grant in connection with this work.

RAJARAM COLLEGE,
KOLHAPUR

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SYNTHETICAL ANTHELMINTICS—PART IX

α Alkyl γ 4-methoxy-3-tolyl, and α alkyl γ 4-methoxyphenyl butyrolactones

By

S. U. MEHTA, J. J. TRIVEDI, K. V. BOKIL AND K. S. NARGUND

ROSENMOND and Schapiro showed that γ 4-methoxy-3-tolyl butyrolactone and γ 4-methoxy phenyl butyrolactone had each thrice the anthelmintic properties of santonin. (Arch. Pharm. 1934, 272, 313). The effect of introducing an alkyl group in γ position in the above lactones has already been studied by Trivedi and Nargund. (Jou. Bom. Univ. 1941, vol. 10, part 3, 102-105). The present paper deals with similar lactones but having an α alkyl group.

The condensation of alkyl succinic anhydrides with o-cresol methyl ether by Friedel and Craft's reaction gave α alkyl β-4-methoxy-3-toluoyl propionic acids, the constitutions of which were established by oxidation and the formation of pyrilium derivatives. These keto acids on reduction by sodium and alcohol and then lactonisation by dilute

sulphuric acid by the procedure of Trivedi and Nargund (Jour. Bom. Univ. 1941, vol. 10, part 3, 99-101) gave ∝ alkyl γ-4-methoxy-3-tolyl butyrolactones. Similarly the reduction of ∝ alkyl β-4-methoxy benzoyl propionic acids described by Mehta, Bokil and Nargund (Jour. Bom. Univ. 1943, vol. 12, part 3, 64) gave ∝ alkyl γ 4-methoxy phenyl butyrolactones.

EXPERIMENTAL

Alkyl succinic anhydrides were prepared by Mehta, Bokil and Nargund's procedure. The yields of the keto acids obtained by Friedel and Crafts reaction are given below.

Alkyl Succinic Anhydride Used	Keto Acid Obtained	Yield Per Cent
Ethyl succinic anhydride	∝Ethyl β-4-methoxy-3-toluoyl propionic acid	40
n-Propyl succinic anhydride	∝n-Propyl β-4-methoxy-3-toluoyl propionic acid	45
n-Amyl succinic anhydride	∝ n-Amyl β-4-methoxy-3-toluoyl propionic acid	30

∝ *Ethyl β-4-methoxy-3-toluoyl propionic acid*:—It was soluble in methyl and ethyl alcohols, acetic acid, benzene and chloroform but insoluble in petrol. It crystallised in short needles when its solution in benzene petrol mixture was cooled in ice. m. p. 99°. On oxidation by sodium hypobromite it gave 4-methoxy-3-toluic acid identified by mixed m. p. with an authentic specimen. It formed a deep red pyrilium derivative with salicyl aldehyde and methyl alcoholic hydrogen chloride. (Found C. 67, 0; H, 7.3 per cent. Eqt. wt, 247.4 $C_{14}H_{18}O_4$ requires C, 67.2; H, 7.2 per cent. Eqt. wt, 250.) It formed a semicarbazone m. p. 179°. (Found eqt. wt, 299.7. $C_{15}H_{21}O_4N_3$ requires eqt. wt, 307.)

∝ *N-Propyl β-4-methoxy-3-toluoyl propionic acid*:—It was soluble in methyl and ethyl alcohols, acetic acid, ethyl acetate and chloroform and sparingly soluble in petrol from which it crystallised in plates m. p. 96-97°. (Found C, 68.0; H, 7.7 per cent. Eqt. wt, 261.9. $C_{15}H_{20}O_4$ requires C, 68.2; H, 7.5 per cent. eqt. wt, 264.) It formed a semicarbazone m. p. 159°. (Found eqt. wt, 318.5. $C_{16}H_{23}O_4N_3$ requires eqt. wt, 321.)

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The lactones obtained by reducing the above keto acids as well as the keto acids described by Mehta, Bokil and Nargund *loc. cit.*, are described in tabular form.

5 (a)

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α-n-tetradecyl-β-4-methoxy-benzoyl propionic acid	α-n-tetradecyl-γ-4-methoxyl-phenyl butyrolactone	Plates from alcohol m.p. 79-80°	C, 77.2; H, 10.4 Eqt. wt, 384.6	$C_{25}H_{40}O_3$ requires C, 77.3; H, 10.3 Eqt. wt, 388
α-n-hexadecyl-β-4methoxy-benzoyl propionic acid	α-n-hexadecyl-γ-4-methoxy-phenyl butyrolactone	Crystallised in shining plates from alcohol m.p. 95.96°	C, 77.6; H, 10.7 Eqt. wt, 411.8	$C_{27}H_{44}O_3$ requires C, 77.9; H, 10.6 Eqt. wt, 416

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Introduction

In 1906 Lord Rayleigh(1) demonstrated the widespread distribution of radioactive elements through the rocks of the earth's crust. During the years 1905 and 1906 Lord Rayleigh(2) and Lord Rutherford(3) first saw the bearing of the rate of disintegration of these radioactive substances in the minerals of rocks on the age of the parts of the earth-crust built of them and they thus provided a measure of the age of such minerals and rocks. Then there came in 1907 the researches of Boltwood(4)(5)(6) who made the first attempt to calculate the ages of minerals after the analyses of these minerals for uranium and lead, lead being recognised as the end-product of the uranium-radium series. The extension and supplementing of this work by Joly, Holmes and others, have now enabled us to look to the disintegration of uranium and thorium as the most promising of many methods that have been used in the endeavour to ascertain the age of the earth. Thus the discovery of radioactive property of uranium and thorium, their disintegration at rates, which can be measured, into the end-products isotopic with lead, and the association and accumulation of helium in minerals and rocks containing uranium and thorium have suggested new methods for estimating the earth's age.

The present paper aims at the determination of the geological age of the Deccan Traps of Bombay and Salsette Islands from the actual analyses of the radioactive elements, uranium, thorium and lead contained in them. Chemical methods as applied to the rocks in this paper and given in the Appendix are contrived from the methods of analysis used in the separation of U, Th, and Pb from minerals rich in these constituents.

Occurrence and Distribution

During the long-past history of the earth great floods of lavas have reached intermittently the surface from the depths beneath, covering, in different parts of the world, vast areas of many thousands of square miles. A large part of the Indian Peninsula was affected by a similar stupendous outburst of volcanic energy towards the close of the Cretaceous or the beginning of the Tertiary period. Subsequent to the deposition of the Bagh and the Lameta beds, enormous volumes of lava were extravasated intermittently through fissures and cracks in the crust of the earth. The discharge of lava continued until the previous topography of the country was buried under some 2000 feet (in some places as much as 7000 feet) of lava on an average.

This great volcanic formation, consisting of a thick series of lava and associated pyroclastic materials, is, at the present day, found to spread over a large part of the Indian Peninsula including Cutch, Kathiawar, Gujarat, Deccan, Central India and Central Provinces.

Stratigraphical Features

Although in this trap formation the lavas form the bulk of the entire Deccan Trap series we frequently come across sedimentary beds (inter-trappeans) interstratified with the lava flows. These sedimentary inter-trappean beds, separating the various lava flows, and formed of fresh-water deposits laid down on the irregular surfaces during the eruptive intervals are, on account of their fossil contents, valuable as chroniclers of the past geological history of the periods of quiescence that intervened between the successive outbursts. These inter-trappean beds are confined either to the lowermost or to the uppermost portion of the Deccan Trap series. Moreover, the fossil fauna and flora discovered in the upper inter-trappeans of Bombay are considered to be decidedly much more highly evolved than those in the lower inter-trappeans (of Central Provinces, etc.).

Also, there exists between the infra-trappeans (consisting of Bagh beds, Jabalpur beds and older rocks) and the lower traps a slight unconformity denoting an interval during which the Lametas were exposed to denudation and weathering in pre-trappean times. A similar unconformity is also detected between the Upper traps and the overlying Nummulitic beds of Surat and Broach. The individual lava flows are on an average 15 ft. thick but the total thickness exceeds 6,000 ft. and reaches to nearly 10,000 ft. (maximum) along the coast of Bombay.

Duration of Eruption

Since the question of the age of the Deccan Traps has a direct bearing on the time which intervened between the first outpouring and the final closing phase of the volcanic lavas, it is desirable to consider first the duration of time represented by these formations. That during the periods of quiescence surface lavas were exposed to the atmospheric disintegration is made clear from the layers of red clay or bole which are found lying between some of these trap flows.

The view held by W.T. Blanford(7) that a large division and long intervals of geological time must have been necessary for the accumulation of the Deccan Traps can be well understood from the local accumulation of freshwater deposits abounding in animal and plant remains, and the more highly evolved species of the fossil fauna and flora discovered in the upper inter-trappeans near Bombay than those in the basal inter-trappeans near Nagpur and the Narbada valley.

These considerations lead to the conclusion that a very long period of time must have elapsed between the beginning and close of the volcanic period, while the different outflows did not always rapidly follow each other but were separated by the intervals of varying, and at times even of longer durations.

THE AGE OF THE DECCAN TRAPS

As mentioned in the previous pages the basal flows of the Deccan Traps are capping the Cretaceous Bagh and Lameta beds while the topmost flow is overlain by the Tertiary (Eocene) Nummulitics of Surat and Broach. This field evidence clearly fixes for us the geological range and gives approximately the horizons to show as to when the first flow occurred and when the final outpouring actually ceased. It, therefore, remains to be decided whether the first outpouring of the lava commenced at the close of the Cretaceous or at the beginning of the Tertiary period. The important evidences on which this determination of the age of the Deccan Traps is generally based, are mainly twofold—(*i*) that deduced from the affinities of the fossil flora and fauna found in the various inter-trappean beds in the series, and (*ii*) that derived from the stratigraphic relations of the Deccan Traps with the overlying and underlying rocks.

Recently, the question of the age of the Deccan Traps has attracted the attention of many geologists who have tried to solve the problem from all the available stratigraphic and palæontological evidences. Efforts have also been made, in one instance, to deduce their age from radio-active data. For instance, Dr. Dubey (8) from the "helium-ratios," arrived at a Tertiary period for these volcanic eruptions.

A clear idea as to the age of the Deccan Traps and as to the views held by recent workers in the field is obtained from the recent works of L. Rama Rao(9) and his co-workers. In trying to fix the lower age-limit of the Traps, L. Rama Rao(10) points out the three different areas of Rajahmundri, Nagpur-Chhindwara and Dhamni and Dongargaon in Central Provinces where the earliest inter-trappean beds yield fossils of a definitely Tertiary age. He even goes further to believe that the two thin bands of trap associated with the Cardita beaumonti beds in Western Sind represent not the topmost flows as widely accepted, but are only the lower flows of the formation with a decidedly Tertiary age.

From these and such other considerations regarding the marine fossiliferous sediments found in association with the traps in the strip of country lying between Surat and Broach, Rama Rao definitely concludes that the Tertiary Era had already dawned when the first lavas of the Deccan Traps were poured out.

All the above considerations lead us to believe that the first eruptions which commenced just after the close of the Cretaceous or, what is the same, the beginning of the Tertiary Era continued to pour out throughout and even after the Eocene period.

The stratigraphical and partly palæontological evidences as to the Tertiary age of the Deccan Traps is supported by the earlier purely palæontological evidence of the fossils contained in the inter-trappean beds. As early as 1837 Malcolmson (11) wrote: "Of the other five genera discovered in these fossil beds, two have hitherto been found only in recent or in Tertiary deposits, *viz.*, Limnea and Physa; and the best characterised specimens of some of the others are referable to the same period. It is, therefore, extremely probable that the basalt in which the fossils are imbedded belong to the Tertiary epoch."

At the Twenty-fourth Annual Meeting of the Indian Science Congress held in January 1937, at Hyderabad (Deccan), B. Sahni during the Discussion disagreeing with the then held official view of the Indian Geological Survey, assigned the Tertiary age to the Deccan Traps. Sahni's arguments denying a Cretaceous period and assigning a Tertiary Era to the Deccan Traps were based on the remarks in which he pointed out that the very large proportion of palms among the angiosperms are not known to figure at all so prominently in any known Cretaceous flora as they do in the inter-trappean flora. He also mentions that the genus Azolla has never been recorded from rocks older than the Tertiary; while the occurrence of Nipadites, a typically Eocene genus is, according to him, the strongest support to an Eocene age for the Deccan Traps. At the same meeting of the Indian Science Congress the question was further discussed and the Tertiary age of the Deccan Traps was officially accepted.

The foregoing remarks on the Deccan Traps raise a question as to whether the Deccan Traps of Bombay and Salsette Islands belong definitely to the Tertiary period. For this purpose some specimens from Bombay and Salsette Islands were analysed; the following localities were selected :—

(1) Colaba,* (2) Malabar Hill, (3) Cumballa Hill,* (4) Worli Hill, (5) Bandra, (6) Danda, (7) Jogeshwari, (8) Goregaon,* (9) Borivli,* (10) Trombay, (11) Mumbra, (12) Kalyan, and (13) Elephanta.

From the results of analyses for U, Th and Pb we have calculated the age of the rocks using the formula (12)—

$$\frac{\%\ Pb}{\%\ U + 0.36\%\ Th} \times 7{,}600 \text{ million years,}$$

and the geological epochs have been assigned to the rock samples under investigation following the time-division scales adopted by Barrel(13) and W. D. Urry (14).

INTERPRETATION OF ANALYTICAL RESULTS

While interpreting the results of our analyses we have endeavoured here and elsewhere (15) to point to the applicability of the "Lead-ratio" method which has yielded so far satisfactory results. The present paper includes a number of analyses of specimens from various places in the Bombay and Salsette Islands, the results of which are tabulated on pages 40-41.

*Results of these specimens are published in "A Note on the 'Lead-ratio' Method for Determining the Age of the Deccan Traps." *Current Science*, Vol. X, No. 12.

TABLE

(BOMBAY AND SALSETTE ISLANDS)

Specimen and Slide No.	Name of the Rock	Locality	Structure	Alteration	% Uranium	% Thorium	% Lead	Pb / U+0.36Th	Calculated Age in Millions of Years	Geological Horizon
2	Andesine Andesite	Near Sir Pherozshah Mehta Garden, Malabar Hill (18° 57′ : 72° 48′)	Very compact	None	9.749×10^{-2}	*Nil*	5.925×10^{-4}	0.006	45.6	Oligocene
4	Andesine Andesite	Summit of the Worli Hill, Opposite the Worli Station, Worli (19° : 72° 49′)	Very compact	None	7.155×10^{-2}	*Nil*	5.799×10^{-4}	0.008	60.8	Middle Eocene
5	Andesine Andesite	From the summit of a hillock at Bandra point, the southern boundary of the Salsette Island, Bandra (19° 3′ : 72° 49′)	Very compact	None	7.632×10^{-2}	*Nil*	5.799×10^{-4}	0.007	53.2	Upper Eocene
6	Andesine Andesite	From a quarry near Danda village, Danda (19° 4′ : 72° 49′)	Very compact	No	5.247×10^{-2}	*Nil*	3.866×10^{-4}	0.007	53.2	Upper Eocene
7	Andesine Andesite	From a big exposure in the near vicinity of the Parsi Vegetarian Society Compound Jogeshwari (19° 8′ : 72° 50′)	A little coarse	None	19.080×10^{-2}	*Nil*	7.732×10^{-4}	0.004	30.4	Upper Oligocene

Specimen and Slide No.	Name of the Rock	Locality	Structure	Alteration	% Uranium	% Thorium	% Lead	Pb / U+0.36Th	Calculated Age in Millions of Years	Geological Horizon
10	Prophyritic Basalt	Collected on the way to the hill (337′) from the Mankhurd Railway Station, Trombay (19° 2′ : 72° 56′)	Very compact (Porphyritic)	None	7.155×10^{-2}	*Nil*	9.665×10^{-4}	0.013	98.8	Uppermost Cretaceous
11	Basalt	From the base of a hill (1006′) opposite the Mumbra Railway Station and to the west of it, Mumbra (19° 11′ : 73° 1′)	Compact (zeolitic cavities noticed)	Slight	5.008×10^{-2}	*Nil*	5.799×10^{-4}	0.011	83.6	Lower Eocene
12	Uultra basic lava (Ankaramite) a dyke rock	From the middle part of the hill (347′) at a distance of about ¾ mile to the south of Kalyan Ry. Station (19° 14′ : 73° 7′)	Coarse (Granitic)	Much altered	3.577×10^{-2}	*Nil*	0.966×10^{-4}	0.002	15.2	Middle Miocene
13	Andesite	Elephanta (19° 57′ : 72° 56′)	Very compact	None	7.393×10^{-2}	*Nil*	7.732×10^{-4}	0.010	76	Lower to Middle Miocene

From the Table giving the age determinations of specimens analysed we find that the Deccan Traps of the Bombay and Salsette Islands belong to the Tertiary Era. This corroborates the Tertiary period assigned to the Traps of Bombay on stratigraphical and palæobotanical evidences. In reference to this may be quoted W. T. Blanford who concludes his paper "On the Traps and Inter-trappean Beds of Western and Central India" with a remark that "the eruptions which produced them may have continued throughout a long period of geological time, and the uppermost flows of Bombay and Mahableshwar might even have been contemporaneous with the oldest Tertiaries."

In these results the Kalyan specimen (No. 12) has given an age of 15.2 million years (Middle Miocene). This low result is easily accounted for when it is remembered that the specimen has been taken from a dyke. As dykes are always of later intrusions, the age should be lower than that of the original formation. Excepting the Kalyan specimen, it will be observed that the difference between the ages of various specimens from the adjoining localities in the area selected is about 25 million years. The differences of about 25 million years in our results is much smaller compared to the differences of 111 and 187 million years observed by Dubey(12) in his "Helium-ratio" results of basic lavas.

Considering that the helium method is a standard method for age determination, the difference of 25 million years observed by the "Lead-ratio" method is negligible when comparing geological epochs. Under the circumstances the adoption of the "Lead-ratio" method to determine the geological age of the Deccan Traps may be considered as important.

The Trombay, Mumbra and Elephanta specimens have higher ages of 98.8, 83.6 and 76, million years respectively which correspond to Late Cretaceous, Lower Eocene and Lower Eocene periods. These results may lead us to conclude that these lava flows are older than those of Bombay.

APPENDIX

A RÉSUMÉ OF THE CHEMICAL METHODS AS APPLIED TO THE ROCKS FOR THE DETERMINATION OF U, Th AND Pb.

Determination of Lead :

10 gms. of the rock powder are dried, and the dried sample is fused. The fused mass is digested with HNO_3 and after full digestion the solution is evaporated completely to dryness. The dried residue is again taken in solution with HNO_3 and the mixture again evaporated to dryness. This process of solution and drying is repeated 3 to 4 times till the silica is dehydrated. The residue at this stage is taken up with HNO_3. The clear filtrate obtained contains all the lead present in 10 gms. of the rock powder.

From this clear filtrate PbS is precipitated with the addition of NH_4OH and H_2S. The precipitate is taken in solution with HNO_3 and the clear filtrate is evaporated with H_2SO_4 nearly to dryness. The process is repeated and the cooled residue is treated with water and alcohol. The $PbSO_4$ precipitate is digested with ammonium acetate and the solution is diluted with water. By comparison with the standard solution the amount of lead in 10 gms. of the rock powder is estimated by colorimetric method.

Determination of Thorium :

The dried sample of 60 gms. of rock powder is digested with H_2SO_4 and the cold mass is taken in solution. In this solution thorium is precipitated as hydroxide and the precipitate again dissolved in HNO_3. Thorium is once again precipitated as thorium

iodate and again dissolved in HNO_3. Re-precipitation of thorium is carried out with ammonia and the precipitate re-dissolved in HCl. Thorium is finally precipitated as oxalate, dried, ignited and weighed as thoria.

Determination of Uranium :

The dried sample of 50 gms. of the rock powder are digested with aqua regia. After complete decomposition the solution is taken to complete dryness, the dried residue is treated with HCl and the filtrate is preserved for the determination of uranium. From this solution containing uranium, members of the H_2S group are precipitated and filtered off and the filtrate is kept for the determination of uranium.

The solution is then neutralised with $(NH_4)_2CO_3$ and the hydroxides of iron, *etc.*, are filtered off. The separation of uranium from vanadium in the filtrate is next effected by precipitation of the former as a phosphate. This uranium phosphate is dissolved in H_2SO_4 and the solution is evaporated to dryness, after which it is once again taken in solution with H_2SO_4. Uranium is determined by titration with standard potassium permanganate solution.

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GEOLOGY DEPARTMENT,
ST. XAVIER'S COLLEGE,
BOMBAY

[*Received: January 29, 1944*]

NOTES AND NEWS

Methods of Research

The Rule-of-Thumb Method

THE manager of a glass factory was of a foreman type. He had no knowledge of the elementary principles of science. By long experience and the practice of rule-of-thumb method he had acquired the art of making glass of ordinary quality used for making ordinary bottles. One day he received a big order for making red-coloured glass. He had never before made glass of that colour but he thought that with the help of a book of recipes, he would be able to make red-coloured glass. So, he accepted the order. The chemical mentioned in the recipe for producing the red colour was oxide of copper ; the other ingredients were sand, soda and limestone. The manager took all the materials in the proportions given in the recipe. He expected to get red-coloured glass but to his surprise and chagrin he obtained glass of a green colour. He repeated the process on the same large scale as before, thinking he must have made some mistake, taking all possible precautions, but the result was again the same. As he did not know the *principles* of glass manufacture he could not understand why he did not get the red colour ; he felt himself groping in the dark. He had already lost heavily financially; so, he finally decided to take the advice of a consulting chemist. He told him what ingredients he had used and in what proportion. When the chemist asked the manager what oxide of copper he had used, cuprous or cupric, and whether he had carried out the process under a reducing atmosphere, he simply looked on and did not reply, for he had not known up to that minute that there are two varieties of copper oxide, cuprous and cupric, and that the cuprous oxide is used for the production of red glass, provided the reaction was carried out in a reducing atmosphere and the cuprous was not allowed to get oxidised to cupric. This was too much for him. He did not know that it was as fatal to his business to use cupric oxide when cuprous oxide was required as it was to the life of a man to give *mercuric* chloride (corrosive sublimate) when *mercurous* chloride (calomel) was to be given as a purgative.

The Scientific Method

The manager failed to solve this difficult problem because he thought that the method which he was following, namely the rule-of-thumb method, was a perfect method, for it had never failed him so far in the narrow sphere in which he was working. From his failure in making the red-coloured glass he became aware of a new method, the scientific method of approach, which was based on the study of the principles of different sciences, and further, that the knowledge and acquisition of which would help him to a better understanding of the mechanism of glass-making of different colours, where before he was groping.

This was the first stage—the use of the rule-of-thumb method—in the history of industrial progress. This was followed by the employment of

the scientific method, and later on by scientific research. The manager of a well-conducted factory now is a highly trained scientist, thoroughly equipped in the knowledge of, and conversant with, the *modus operandi* of the different steps in the various processes of manufacture. He is therefore able to control each step and get the final finished product of the best possible quality and in the largest possible quantity. By the employment of scientific method and the judicious use of research, both science and industry advanced rapidly. Each affected, and was affected by, the other.

The 19th Century

The 19th century was the heyday of science and industry. Claims were put forward by some of the eminent scientists of that century that science was able to explain everything and was able to solve "the riddle of the universe" (Hæckel) ; that the scientific method was the only method of discovering truth and reality ; that the scientific training and discipline was so superb in building human character that religion was relegated to an inferior position or ignored altogether.

The 20th Century

The 20th century brought new and difficult problems, partly as a result of the introduction of power and machine and partly as a result of the outlook on life given to it by the 19th century scientists. Instead of the riddle of the universe being solved by science, it has become more complicated, for the scientist of the year 1944, in spite of the tremendous progress of science in this century, finds himself faced with grave, knotty problems, such as poverty, unemployment, wars, deadlocks in every department of life, crises in science and society, frustration of science, deliberate destruction of foods and goods, deliberate planning for scarcity while millions are starving, half-clad and homeless, and while both industry and science are capable of planning for plenty, deliberate planning for curtailment of new machinery and smothering of invention, deliberate planning for reducing the scientist to a mere henchman of the capitalist-industrialist, overproduction being considered a curse, "Poland's good harvest" considered as a "severe blow to trade," the lamentations of the rubber growers over the improved method of increasing production and "the hailing of rubber pests as angels from heaven," an exhibition of the depraved human nature, lust and greed, intellectual callousness, ruthless cruelty, the spreading of deliberate falsehood and untruth, etc., etc.—the scientist of the present day feels himself staggered by the host of problems which have cropped up and which he finds himself incapable of solving.

Limitations of Science

The scientist of the present age finds once again that the laws of nature which he once thought held good at all times and under all circumstances are now found to be insufficient for the astronomical world and to fail totally for the world of atoms and sub-atoms ("Physics and Philosophy" by Sir James Jeans). The scientist of the present day has now become humble and is fully conscious of the limitations of science and of its methods in the investigation of phenomena in the sub-atomic world and we may further suppose that he is equally fully conscious of the limitations of

the scientific training and discipline in the refining and ennobling of human nature.

Is There an Explanation?

How to account for this chaos and conflict in the world, why this moral and spiritual anarchy in spite of the tremendous advance of science? Is there an explanation of the occurrence of deadlocks in human affairs, and crises in society and science? Is it possible that the scientists and leaders of society are groping in the dark as did the foreman-manager when he was confronted with the problem of making red glass? Is it possible that the scientists and leaders of society are unaware of the laws of life, that they are ignorant of the principles on which man's whole life is based, that they are ignorant of the true nature of man and of the universe, as was the foreman-manager regarding the nature of red glass and the process of its manufacture? Is it possible that the scientists and leaders of society, who are primarily men, are drifting on the ocean of life aimlessly, not knowing what they really are, what their goal in life is, what their destiny, that they are not able to solve the current complicated problems—economic, political, social and educational? Is it possible that the present-day man, because of his incomplete concept about himself and his incomplete philosophy of life, is not able to resolve the many deadlocks with which he is faced in society?

A Challenge to the Scientists

It is high time that the scientists of the present day must face these problems bravely and try to find out their solutions. If they find from their investigations that the scientific method of inquiry is not sufficient in certain cases and has failed them in others, then they must *supplement* it by another method. If they find that the scientific training and discipline has failed to make man gentle, compassionate, more understanding, more considerate, then they must *supplement* it by another training and discipline which may have the power to transform the present-day selfish, exploiting animal-man into a truly loving, self-sacrificing, co-operating human being, willing to share what he has got with others.

The Inadequacy of the Rule-of-Thumb Method

The rule-of-thumb method of the foreman-manager led him into a financial disaster. It was found to be inadequate and had to be replaced by the scientific method.

The Inadequacy of the Scientific Method

The scientific method of inquiry has served the scientist remarkably well in his investigations in a man-sized world but is found to be insufficient for the astronomical world and to fail completely in the world of atoms and sub-atoms (Review of "Physics and Philosophy" by Sir James Jeans, *Science and Culture*, January 1944, p. 259). We yield to none in our admiration of the scientific method, the value of which for researches in physical phenomena in a man-sized world we fully appreciate and which, we believe, will serve the scientist beautifully for hundreds of years to come. But where the scientific method has been found to fail or to be insufficient in the cases we have seen above and also in the study,

not of physical man, body and brain, but the psychological man, mind, intuition and spirit, then it requires to be *supplemented* by another technique.

The Occult Method

The new technique we suggest is the occult method. The occult method of investigation and the occult training and discipline will, we believe, fill up the gaps and deficiencies in the present-day scientific method of investigation and the present-day scientific training and discipline.

What Is This New Technique ?

What is this occult method ? And how is it going to help us to solve the multifarious problems which face us, not only in the outer world of affairs but also in the sub-atomic world where the present technique has failed us ?

D. D. KANGA

BOOK REVIEWS

A Text-Book of Physics. By S. V. Divekar, B.Sc., S.T.C., B.T.; Published by Hind Printing Works, Bombay 4 ; 1943.

AMONG a plethora of school-books that are released from press from time to time, invariably a few are found to be really suited to the needs of students. If a book covers the prescribed course, it may not be necessarily valuable. Mr. Divekar's Text-Book of Physics fully covers the present Matriculation course of the Bombay University and more or less satisfies its fundamental requirements. The sequence of the topics being dictated by the author's own experience of the teaching of the subject for a number of years, would, it is believed, be acceptable to those who are in the teaching line. Initiating the subject from its most interesting part, *viz.*, Magnetism and Electricity with its diverse fascinating experiments, the author passes on in succession to light, sound, general properties of matter, mechanics and heat. As to how to maintain the students' sustained interest in this chain, depends upon the skill of the teacher. In this respect, a successful teacher is one who would talk less and impart more by way of experimental demonstration, thus dispensing with the students' need to use the book more than observation. The present book has been very carefully written and produced and profusely illustrated by diagrams. But the author, in his zeal for clear exposition of the numerous topics, is inclined to be a bit more on the side of abundance than preciseness, with the result that the book has become somewhat more bulky. Some of the matter could have been condensed to minimum, leaving the teacher to do his part, *viz.*, to supplement detailed explanation. This would have made the book an ideal text-book, and as such indispensable to students. But in the prevailing state of inadequate scientific resources, equipment and facilities and the minor status of the teaching profession, books form a major vehicle of imparting scientific knowledge. From this point of view Mr. Divekar's attempt is successful, and his book can be safely recommended to students and teachers alike.

N. R. T.

Chemical Aspects of Light. By E. J. Bowen ; Oxford University Press, London ; 1942 ; pp. vi+191, 12s. 6d.

THE book under review gives a résumé of our present-day knowledge about the interaction of radiation and matter, with particular emphasis on those aspects of the interaction which may be called chemical.

The first chapter deals with light as wave motion, with an elementary explanation of the phenomena of reflection, refraction and interference, followed by a chapter describing various sources of light, their spectral distribution, measurement of light intensity, and colorimetry by colour comparators.

The third chapter which is the longest in the book covering forty-seven pages, deals with absorption and emission of light, by atoms and molecules, and sets forth some of the modern conceptions about the atomic and molecular structure and their ionisation or dissociation, after a consideration of their spectra and energy states. This account, though necessarily sketchy, would be helpful to a careful reader, who wishes to acquire a knowledge of the subject in its broad outline. In this chapter, Figure 14 depicting a simple absorption spectrum of a diatomic molecule, seems to need revision, for here, two bandheads having a considerable difference in energy, are shown to have the same transition 0-5. A similar case is that of the transition 2-3.

The transformation of absorbed radiation, by atoms and molecules, or its degradation into other forms of energy, kinetic, radiant or chemical, and the ultimate fate of the absorbing species, form the subject matter of the eight succeeding chapters dealing with luminescence of solids, photochemical reactions, photosynthesis in plants, the photographic process, reactions of the eye to light, photocells and chemiluminiscence. All this covers about eighty-five pages and brings the text of the book to its end. The reader will find here an informative account of those chemical effects of light which are responsible for a number of phenomena of paramount interest.

Four appendices deal with light filters, technique for the measurement of quantum efficiency of a photochemical reaction in solution, and preparation of some inorganic phosphorescent substances. Details about light filter materials, coloured glasses, gelatin films and solutions, are useful, but in addition it would be desirable to have a knowledge about the light transmission qualities of each of the various combinations suggested. References to original literature would have been helpful in this case. Two of the filters suggested here for the yellow and the green mercury radiations are due to C. Winther (Zeit. f elektrochemie, 691, *43*, 1937), and have good monochromatic transmission of 47 and 58 per cent respectively.

Small differences between the values of the various physical constants given at the end, and those recently reported by Birge (Reports on Progress of Physics, Vol. 8, 1941, Physical Society, London, 1942) are observed, but these would be perhaps corrected in the next edition.

The book provides a valuable reading for all interested in the behaviour and working of light on its impact with matter. As an Oxford University Press publication it is an elegent production free from typographical errors.

B. K. VAIDYA

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CONTENTS

EXTERNAL MORPHOLOGY AND ANATOMY OF SCORPION

(Buthus tamulus Fabr.)

(In continuation of the earlier part published in Jour. Univ. Bom., Vol. XI, Part 3, 1942)

By

V. B. TEMBE and P. R. AWATI,

Royal Institute of Science, Bombay

THE RESPIRATORY SYSTEM

THE respiratory system of the scorpion consists of four pairs of book-lungs. They have lateral and oblique slit-like openings situated on the ventral surface of the ninth, tenth, eleventh and twelfth segments. At the edge of the slit or stigma the chitinous lining is thickened and is provided with bristles which prevent dust particles entering it from outside. The stigma opens into a thin-walled chamber called the pulmonary chamber. The latter contains a basal shaft carrying 130—150 blood-holding, thin plates or lamellæ lying one on another like the leaves of a book. The lamella is also a compressed sac with thin membranous walls and is filled with blood brought to it from the ventral sinus. According to Lankester [4] the book-lung is a modified appendage which has retracted into the body and has developed a recess or chamber which communicates with the exterior by a stigma. Each lamella is covered with a very delicate chitinous layer. If it is examined under the microscope, the chitinous layer is seen to be formed of irregular rod-like thickenings. The gap between two adjacent lamellæ is the air space and it is maintained by the bristle-like rods or processes (Fig. XXIV) of these chitinous layers. These processes lie at an angle to the lamellæ.

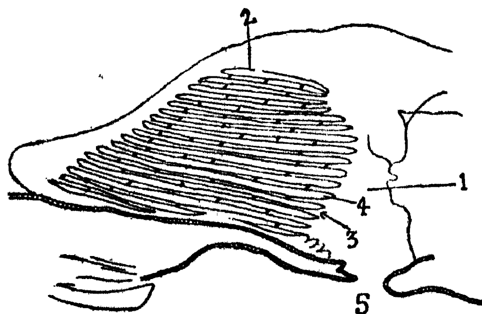


FIG. XXV. Longitudinal section of the book-lung.

1 Pulmonary chamber, 2 Lamella, 3 Air space, 4 Blood space, 5 Stigma.

In a longitudinal section of the book-lung (Fig. XXV) each lamella appears to be formed of thin epithelium, the free end of which is thickened. Inside the lamella some blood corpuscles are seen. The chitinous processes of a lamella alternate with those of the other, so

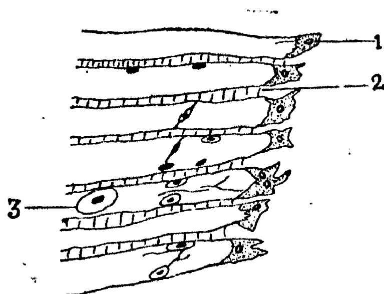


FIG. XXVI. Longitudinal section of blood lamellæ.

1 Epithelial cell, 2 Chitinous processes between the two lamellæ, 3 Blood cell.

that the lamellæ rest on each other and the air cavity is maintained (Fig. XXVI).

The air from outside enters through the stigma into the pulmonary chamber and from there into the air spaces. Owing to the thin nature of the membrane of the lamellæ the exchange of gases takes place. The blood is returned to the pericardial sinus through the paired veno-pericardial veins.

THE RESPIRATORY MECHANISM

The paired veno-pericardiac muscles connect the roof of the ventral sinus with the ventral wall of the pericardial sinus as already mentioned (Vol. XI, p. 76). The contraction of these muscles enlarges the sinuses and is believed to facilitate the circulation of blood through the gill-lamellæ.

Blanchard [7] in 1851, observed the rhythmical movement of the dorsal wall of the lung sacs, causing the opening and shutting of the stigmata. Plateau in 1887, on the other hand, using methods of graphical recording, failed to discover any movement of the respiratory apparatus.

Gothfried Frænkel [2] (1930) observed the respiratory mechanism in the case of *Buthus quinquestriatus*. He found that cardiac and pulmonary pulsations are of equal frequency. The heart motion is carried over to the lungs. The pulmonary pulsation ceases when the connecting band between the two organs is severed. He has also shown that the respiratory process in the scorpion consists of two components : (1) the little pulsations of the lungs, which maintain a continuous ventilation, important apparently in keeping the layers of air next the lamellæ in motion ; and (2) the opening of the stigmata and the expansion and contraction of pulmonary sacs connected therewith.

Except the book-lungs respiration there is no other respiration in scorpions, as shown by Zoond [15] by experiments that in scorpions the respiratory exchange is entirely localised in the book-lungs and there is no cutaneous respiration. He however states that the respiratory movements are absent in the scorpion although they were observed by Gothfried.

THE NERVOUS SYSTEM

The central nervous system consists of the brain and the ventral nerve cord.

The brain is very small and is situated in the cephalo-thorax just beneath the median eyes. In the adult scorpion the different ganglia of

the brain are completely fused together and can be roughly differentiated into two nerve masses—the dorsal or cerebral nerve mass and the ventral or thoracic nerve-mass. These two nerve masses are connected with each other by means of a pair of commissures which pass round the œsophagus. The commissures are so thick and short and the œsophagus is so narrow that it is rather difficult to distinguish them from the brain proper. A microscopic examination of the brain by means of microtome sections shows the brain to be really formed (Fig. XXIX) of four parts. The cerebral nerve-mass is divisible into two lobes, by a slight constriction, the dorsal one being the *fore-brain* (2) followed by the *mid brain* (3). The thoracic nerve mass is divided into the *hind brain* and the *accessory brain* on account of their nerve supply.

The *fore brain* consists of two closely united ganglia. From the side of each ganglion a thick nerve starts directly upwards and is given to the large median eye of that side. This nerve is called the optic nerve. At the base of this nerve, on the anterior side is given off a small nerve which passes forwards and inwards around the muscles of the chelicera and divides into three branches which supply the three lateral eyes of that side.

From the *mid brain* on each side a large nerve trunk is given off which passes antero-laterally and supplies its chelicera. From the ventral side of this nerve a small branch is given off which runs along the pharynx and supplies the rostrum. It is known as the *rostral nerve*. Besides these, the mid brain also gives off a number of small nerves which supply the different parts of the pharynx and the œsophagus.

The *hind brain* which is situated below the œsophagus is relatively of a large size and is formed by five pairs of ganglia (Fig. XXVII). The ganglia being completely fused with each other can easily be made out by their nerves. The first pair of ganglia is situated at the anterior end and each gives off a large nerve which is distributed to the pedipalp. Each ganglion of the remaining pairs gives off a nerve which supplies the leg of that side.

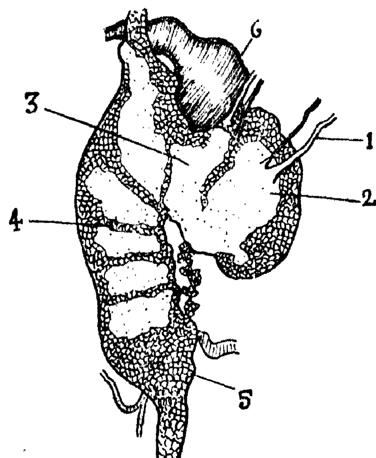


Fig. XXVII. Longitudinal section of brain.

1 Nerve to the median eye, 2 Fore brain, 3 Mid brain, 4 Hind brain, 5 Accessory brain, 6 Pharynx.

On the postero-dorsal side of the hind brain lies the *accessory brain*. From the latter four pairs of nerves are given off which run posteriorly and supply the abdominal segments. These are called the vagus nerves by Pettin [16] (Fig. XXX, 9, 10, 11, 12). The brain is followed by the ventral double nerve cord. There are three ganglia in the abdominal region and four ganglia in the post abdomen.

The nerve that supplies the pedipalp on each side runs through the length of the pedipalp and as it enters the swollen base of the immovable finger, it divides into two branches. One branch goes to the tip of the immovable finger, while the other supplies the movable finger. The main nerve also gives off many small branches along its course to the muscles of the pedipalp. The nerves going to the legs are uniform in branching and distribution. Each leg-nerve runs through the leg segments and gives off small branches to the muscles which control the joints of the leg and its movements. At the joint of tibia with protarsus the main nerve divides into two which run separately, along each side of the ventral surface of the protarsus and the tarsus, to the claws. According to Newport [6] these branches give distinct nerves to the five spines on the under surface of the tarsus, on which joint the scorpion usually rests. These small nerves which supply the spines appear to be concerned with the sense of touch, since that part of the leg is constantly employed in touching and examining the objects over which it passes.

The vagus nerves that pass backwards from the accessory brain into the abdomen are rather difficult to trace as they give many branches. The first nerve is thick and supplies the pectine, which is a sensory organ. The second nerve runs posteriorly, divides into branches to supply the genital operculum, the genital ducts and the muscles of the 6th segment. These two pairs of nerves also give small branches which are distributed in this part of the abdomen. The third and fourth pairs of vagus nerves running into the abdomen supply the first and second pairs of book-lungs. Each of the nerves, on its entering its segment, divides into two, the anterior branch of which subdivides into many branches to supply the muscles and liver, while the posterior branch supplies the book-lung.

The nerve-cord that follows the brain is slender and rounded in the abdomen and flattened and ribbon-shaped in the post-abdomen. It consists of two halves. Throughout its length the two halves of the cord are closely approximated, excepting immediately anterior and posterior to each ganglion where the blood vessels pass downwards from the supraspinal artery. The first abdominal ganglion of the nerve cord is situated at the posterior region of the 1st pair of book-lungs (9th segment). It gives a branch on each side which passes behind the dorso-ventral muscle of the 10th segment and divides into two branches, of which the anterior runs to the body wall, while the posterior runs back to the 3rd pair of book-lungs in the 11th segment (Fig. XXVIII, 13). The second abdominal ganglion is situated between the 11th and 12th segments. It also gives a similar branch that runs in between the dorsoventral muscles of the 11th and 12th segments, and divides into two, the posterior branch supplying the last pair of book-lungs. The third abdominal ganglion lies in the anterior part of the 13th segment and gives off a pair of nerves which divide into many branches to supply the muscles of that segment.

In the ribbon-shaped nerve cord of the post-abdominal region there are four distinct ganglia, situated each at the anterior end of each of the first four segments (segments 14, 15, 16 and 17). The ganglia of the post-abdomen are elongated, and flat like the cord in this region. Each of these ganglia gives a pair of nerves which are divided into two sets of branches. The anterior set is shorter and is directed anteriorly and supplies the muscles of the ventral side of the segment. The posterior

set is longer and is sub-divided into four branches which pass posteriorly and dorsally to the great flexor muscles. The fourth ganglion of the post-abdomen gives off two pairs of nerves. The first pair forms the proper nerves of that segment, while the second is the continuation of the two halves of the cord and are called the terminal nerves (Fig. XXVIII). These nerves pass posteriorly one on each side of the colon and ascending inwards on the dorsal side come close together at the posterior part of the 4th post-abdominal segment (17th segment) from where they run into the 18th segment but on the dorsal side of the colon. At the anterior joint of the 18th segment each nerve gives off a large branch to the muscles of the segment. Immediately after the large branch, a small branch is given off to the anterior region of this segment. At the posterior end of the 18th segment each of the terminal nerves gives off a branch on the respective side, to the anus. Thus the anus is enclosed between the elongated nervous collar. Immediately posterior to the anal nerves the terminal nerves give branches to the base of the sting and the main nerves, now reduced to small size, pass along the dorsal median line into the telson and supply the poison ducts to their extremity.

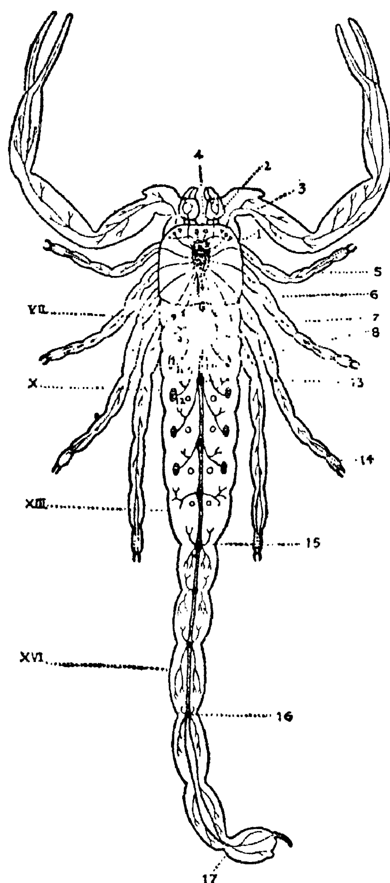


FIG. XXVIII. Nervous System.
1 Brain, 2 Nerve to Chelicera, 3 Nerve to Pedipalp, 4 Nerve to Median eye, 5, 6, 7 & 8 Nerves to Walking legs, 9, 10, 11 & 12 Vagus nerves, 13 1st abdominal ganglion, 14 Nerve to the spines of the leg, 15 1st post-abdominal ganglion, 16 7th ganglion, 17 Nerves to the telson, VII, X, XIII & XVI segments.

THE EXCRETORY SYSTEM

In scorpions the excretory function is performed by three different organs in the body.

(1) The Malpighian tubules.
(2) The Coxal glands.
(3) The liver.

(1) The Malpighian Tubules

The Malpighian tubules originate at the point of constriction between the pars tecta intestini and pars nuda intestini in the 13th segment. They open on each side by a common opening into the posterior end of the pars tecta intestini. There are two pairs of Malpighian tubes, very small in size (Fig. XIV). One pair which is very long runs along the pars tecta intestini towards its anterior end, Povlovsky.[10] The second pair is small and runs anteriorly and laterally into the liver lobes. Unlike those of insects the Malpighian tubes of scorpions originate as an outgrowth of mesnterone, Laurie.[17] In a freshly dissected specimen these tubes appear rather brownish, and they contain minute granules.

A transverse section of the tube (Fig. XXIX) shows that it is made up of large, cubical epithelial cells which vary in size and shape according to the physiological activity. At places the lumen is very narrow. The tube is covered by a thin peritoneal sheath (1), in which are a few muscle fibres scattered irregularly ; but at the base of the tubes more definite longitudinal and circular muscle fibres are seen. The muscle fibres seem to be continuous with the musculature of the intestine.

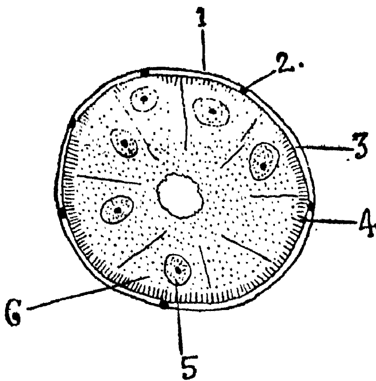


Fig. XXIX. T.S. Malpighian tube. 1 Peritoneal sheath, 2 Longitudinal muscle, 3 Basement membrane, 4 Striation of the cytoplasm, 5 Nucleus.

Beneath the peritoneal sheath is seen a basement membrane (3) of the tube on which the entire epithelium of the tube rests. The epithelial cells are very large and at the base of the cells is seen a very fine striation of the cytoplasm at right angles to the basement membrane. The nuclei (5) are large and deeply stained. At the free end of the cell and in the lumen, the excreted material is found.

(2) Coxal Glands

The coxal glands are a pair of brilliantly white oviform excretory glands found in the sides where the coxæ of the 3rd and 4th pairs of legs join the sternal wall of the prosoma. Newport [6] and others erroneously regarded them as parts of the alimentary canal.

Lankester [18] for the first time, called them coxal glands and identified them to be analogous to the "brick-red" glands of *Limulus* and to the coxal glands of *Mygale* ; but he was unable to find any duct by which the coxal glands open to the exterior. It was Laurie [17] who showed in his embryological studies that in the embryo of the scorpion they open outside by a duct on the coxæ of the 3rd pair of legs. Similar observations were made by Gulland who showed that in the embryo the coxal gland is a comparatively simple tube which opens to the exterior by one end and into the cœlomic space by the other.

Bernard [19] showed that the opening to the exterior also persists in the adult scorpion. These glands communicate outside by a very minute aperture on the posterior face of the coxæ of the 3rd pair of legs.

The transverse section of the coxal gland shows that it consists of three main regions (Fig. XXX) : (*a*) Medullary region in the centre (4), (*b*) Calca of the gland, and (*c*) Intercalcal spaces (2).

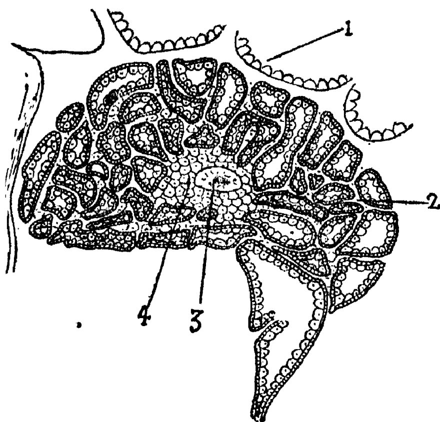


FIG. XXX. Transverse section of coxal gland.

1 Portion of the hepatic gland, 2 Intercalcal space, 3 Blood vessel, 4 Medullary region.

The medullary substance is formed of compact cells and in the centre of it passes a blood vessel (3). Lankester [18] states that presumably the contents of this blood vessel are in communication with the lacunar space of the inter-calcal regions of the gland. The medullary tissue seems to be extended into the inter-calcal spaces.

The inter-calcal spaces are bounded by connective tissue frame-work (Fig. XXXI). This connective tissue is very minute, and very careful study will show nucleus and the tissue in the inter-calcal.

The dissection of the glands from a fresh specimen, shows that the coxal gland is formed of a coiled tube bounded completely by the connective tissue. It is due to this coiling that we get the different calca in the sections.

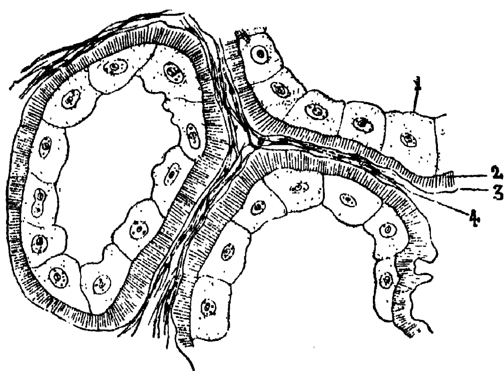


FIG. XXXI. Transverse section of a portion of the coxal gland.

1 Epithelial cell, 2 Striated cortical layer, 3 Basement membrane, 4 Connective tissue.

In the transverse section it is found that the tube consists of a basement membrane (Fig. XXXI, 3) and the large epithelial cells (1). At the base of the epithelial cells the cytoplasm has a striated appearance and this region takes a deep stain. Lankester has called this region as the *striated cortical layer* (Fig. XXXI, 2).

In the epithelial cell there is a big nucleus and granules are found in the cytoplasm. In the lumen there is a coagulated substance which is the discharged material.

The liver of the scorpion also serves as an excretory organ. Already we have seen the presence of pigment granules in its cells (Fig. XXII). Povlovsky [10] had injected ammonia carmin into the body cavity of scorpions (B. Australis, B. Cancasieus, B. Cupersis) and he observed in several cases a distinct excreta of carmine by the liver. The carmine was excreted only by the resorption cells (6) in which it was deposited in the form of minute bright red granules of big globular inclusions. The ferment cells (7) were always free from carmine. The solution of trypan blue, trypan red and isamino blue produced no effect on the liver. This is quite contrary to the observation made by J. Pearson [11] who states that in Cancer (crab) the ferment cells work as excretory organs.

REPRODUCTIVE SYSTEM

The scorpions are viviparous. The sexes are separate. The male differs from the female in having the tail longer, the hand rounded and thick, considerably thicker than the brachium, the length of the under-hand about three quarters of that of the movable digit, and the digits lobate and separate at the base when closed. The pectinal teeth are 28 to 30 in female, and 30-34 in males.

The Male Reproductive System

The male reproductive system (in B. tumulus) consists of (1) two pairs of testes, (2) a pair of vasa deferentia, (3) a pair of vesicula seminalis, (4) a pair of ejaculatory ducts, (5) the so-called double penis, and (6) two pairs of accessory glands (Fig. XXXII).

The two pairs of testes in the form of longitudinal tubules are situated one pair on each side of the alimentary canal and extend from the 9th to the 12th segment. The tubes of each pair are connected with each other by four transverse tubules. Each transverse tubule is situated posterior to the dorso-ventral muscle of that segment. Thus the testis of each side forms a series of three squares (5). At the anterior and outer angle of the anterior square of each pair a single canal is given out which runs anteriorly, ventral to the so-called penis of that side. This is the vas deferens (6). The vasa deferentia runs forward up to the 8th segment, then turns inwards and up towards the dorsal side, and opens into a bulging sac which is the vesicula seminalis. (7). Here the spermatozoa congregate. The vesicula seminalis opens anteriorly by a fine duct into the bulbous part of the ductus

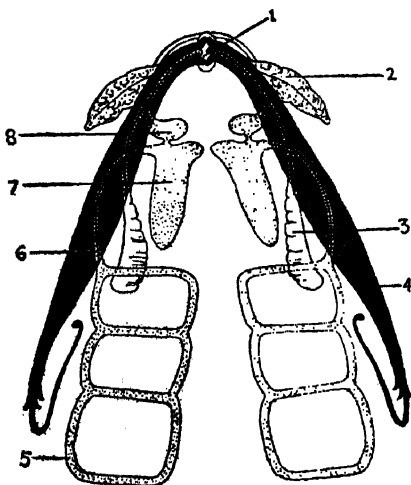


Fig. XXXII. Male Reproductive System.

1 Genital opening, 2 Ventral accessory gland, 3 Dorsal accessory gland, 4 Chitinous rod (Penis), 5 Testis, 6 Vas deferens, 7 Vesicula seminalis, 8 Bulb-like portion of the ejaculatory duct.

ejaculaterius (8). The ductus ejaculaterius runs along the groove of the penis and the ducts of both sides open by a common opening, the genital opening (1).

Transverse section of testis (Fig. XXXIII) shows that the tubule is covered on the outside by the basement membrane (2) supported by the layer of thin connective tissue. Inside the basement membrane is situated the germinal epithelial layer which is divided by septa (1) into different lobules. There is an irregular lumen in the centre. A careful study of transverse section of mature specimen shows the spermatogonia spermatids and spermatocytes. The sperms are found in bunches in the lumen. The spermatozoa are motile having an oval head and a long tail.

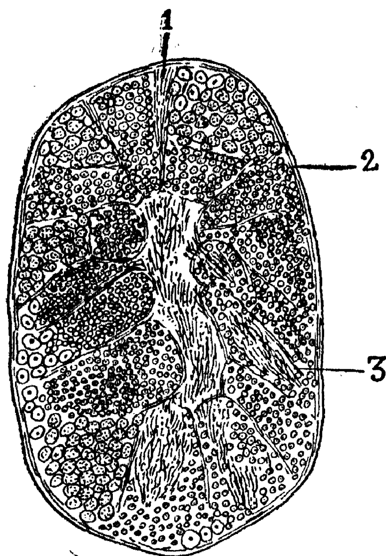


FIG. XXXIII. Transverse section of testis.

1 Septum, 2 Basement membrane, 3 Sperms.

The accessory glands :—There are two pairs of accessory glands (Fig. XXXII, 3 and 2). The first or the dorsal pair is long, wide and sac-like. It is situated between the vesicula seminalis and the chitinous rod of the penis. It gives out a duct which runs anteriorly and opens into the straight part of the ejaculatory duct. It has got columnar cells which stain deeply. The second or the ventral pair is smaller (2) and is situated on the ventral side of the chitinous rods. The glands are of racemose type and open separately in the genital opening. They have got small columnar cells.

The so-called double penis :—There is a pair of chitinous rods extending from the genital opening to the 12th segment, one on each side (Fig. XXXII, 4). They are broad at the opening and go on narrowing at the end and are covered by a peritoneal membrane. These rods form the so-called double penis of the scorpion. They are grooved lengthwise. At the twelfth segment they are narrowed and give out three hook-like processes. The main portion of the rod turns round and comes up tapering up to the 10th segment, where it ends in a curved point. At the genital opening these rods come close together where each of them has another hook-like process. The terminal duct of the reproductive organs of each side, is just ventral to the groove of the rod of that side. These rods seem to serve as claspers in the act of copulation.

The genital operculum consists of two chitinous plates each of which is hinged anteriorly so that it can be turned forward and outward. These opercular plates are attached by adductor muscles.

M. Narayanan [20] has described a pair of processes called subopercular plates below the operculum in the case of Scorpio fulrnipes. We did not find these processes in the B. tumulus. Perhaps the said processes might be the anterior ends of the internal chitinous rods.

The Female Reproductive Organs

The female generative organs consist of three longitudinal tubes connected with each other by transverse tubes, so as to form eight squares (Fig. XXXIV). These constitute the so-called ovaries of this scorpion. The longitudinal ovarian tubes are extended in the body cavity parallel to and below the digestive canal beginning from the 9th segment and reaching posteriorly as far as the end of the 12th segment. About the middle of each segment they are connected by transverse canals. From the lateral angles of the two anterior most squares are given out the oviducts which run anteriorly and open by a common aperture to the outside on the 7th segment. The genital opening is covered by a small valve-like flap called the genital operculum which consists of two chitinised plates, just like that of the male. M. Narayanan [20] has described that there is only a single plate of genital operculum in the female of Scorpio fulrnipes. In B. tumulus we get two plates.

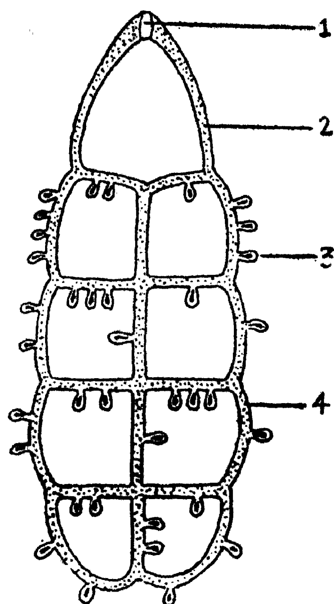


Fig. XXXIV. Female roproductive system.

1 Genital opening, 2 Oviduct, 3 Egg follicle, 4 Longitudinal ovarian tube.

In dissecting the specimen the ovary appears to be embedded in the hepatic gland, the chief portion of which lies dorsal to it, but this is not really the case, for though lobes of the hepatic glands pass through the ovarian frame-work, they do not unite on its ventral side. All the longitudinal and transverse tubes are germinal tracts which develop ova that project on their external surface, in the form of oval bodies. Each of the ova is attached to the tube by a short pedicle. The ova are in different stages of development. On the ovarian tubes are found the remains of follicles after the mature ova are liberated from them. Laurie [17] has called them as "Corpora Lutea."

The wall of the ovarian tube consists of two layers surrounding an irregular lumen (Fig. XXXV). The outer layer consists of polygonal cells bounded by the connective tissue layer. These cells contain circular nuclei and possess strongly marked cell walls. The contents of these cells are highly refractive. Towards the inner side of this layer the cells become flattened so as to form a distinct cellular limiting layer.

The inner layer which surrounds the lumen of the tube consists of very long and thin columnar cells based on a very fine structureless membrane. This is the germinal epithelium (2). These cells have oval big nuclei and clear faintly granular cytoplasm. The nuclei are generally situated in the central area. It is from this inner layer of cells that the ova and their follicles are formed. When an ovum is developed it projects completely through the outer layer and is visible to the naked eye in the form of a small protuberance. It remains connected to the inner layer of the tube by a column of cells which constitute the pedicle. They also grow round the ovum so as to form a follicle.

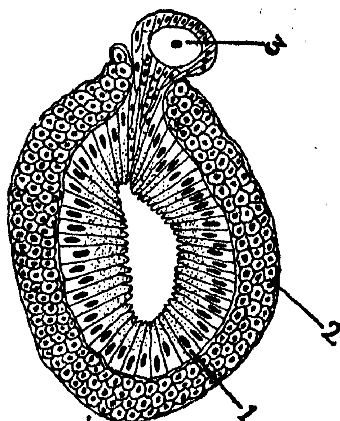


FIG. XXXV. Transverse section of the ovary.

1 Outer layer, 2 Germinal epithelium, 3 Ovum.

After the young scorpions have been born the diverticulum collapses and degenerates assuming various and variable forms. These are the corpora lutea.[17]

THE POISON GLAND

The metasoma ends in a postanal sclerite called the telson. In the ampulla of the telson there is a pair of poison glands, one on each side of the middle line. Each gland (Fig. XXXVI) is covered by strong muscles from the mesial and dorsal sides. These are the compressor muscles, which are richly supplied with blood vessels and nerves. When these muscles contract the poisonous secretion is ejected from the gland. From the posterior end of each gland a duct is given out which runs along the oculeus and opens separately just before its extreme end. The openings of the two glands are very close together.

In transverse section the gland seems to be composed of many folds of columnar cells of glandular epithelium based on connective tissue layers. The extent of the muscular contraction and consequently the amountof venom injected seem to be under the control of the animal and is variable according to the circumstances.

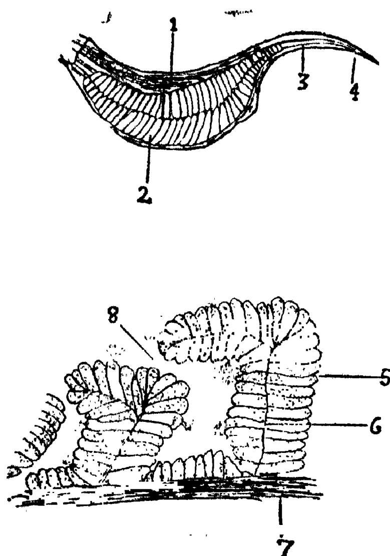


FIG. XXXVI. The Poison Gland.

A. Longitudinal section of telson.

B. T.S. of a portion of poison gland.

1 Dorsal compressor muscles, 2 Poison gland, 3 Poison duct, 4 Opening of poison duct, 5 Glandular cells of the poison gland, 6 Basement membrane, 7 Mesial muscles, 8 Space between the two folds where the poison is secreted.

It seems that the quantity of venom is variable in different individuals according to their size and may vary from 8 to 60 mg.

The venom is a tasteless, odourless, faintly acid, viscous liquid. The first drop is always clear and colourless and dries to a transparent vitreous pellicle which appears faintly yellowish. The next two or three drops are clear and opalescent, the rest white and opaque. If dried in vacuo the venom forms a white amorphous driable mass which breaks into minute iridescent flakes.

Whether liquid or solid it dissolves readily in water, saline solution and glycerine. It is insoluble in alcohols, ether, chloroform acetone, benzene, xylol and oil.

It has been found by Caius and Mhaskar [22] that the venom is a very complex substance composed of the following active principles : (i) Neurotoxins which act principally on the respiratory centres, partly on the vaso-motor centre, on the nerve end plates in striated muscles and on the responsive mechanism of the parasympathetic and sympathetic in the secretory glands. (ii) Hemo-lysins, agglutinins, hemorrahagins, leukocytolysins, coagulants, ferments, lecithin and cholesterin, (iii) a cardiac tonic, (iv) a vascular tonic.

Generally it has no fatal effect on man ; but Omar [25] has given a fatal case of scorpion bite.

The sting of B. Tamulus produces the following (Caius [22]) symptoms : Burning pain, cold perspiration, shivering pain and muscular twitching, ameliorated in two hours. One fatal case exhibited perspiration, vomiting, foaming from the mouth till death.

The sting of the scorpion is primarily a weapon for paralysing its prey. Scorpions seize their prey with the pedipalpi, hold them close to the mouth by means of the cheliceræ and sting them if necessary, by bringing the metasoma forwards over the mesosoma and cephalothorax and inserting the tip of the telson well into the animal's body and allowing it to remain there until the poison has had time to act.

Scorpions never sting unless disturbed and this too under grave provocation ; as a rule they simply whisk their tail just as we do our hand when disturbed by a troublesome fly.

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A STUDY OF FISH EGGS AND LARVAE FROM MANX WATERS

II. Observations on the Fish Larvæ

By

DR. D. V. BAL, M.Sc., Ph. D. (L'POOL), F.A.Sc.,

Department of Zoology, Royal Institute of Science, Bombay

CONTENTS

INTRODUCTION

THE material on which the present paper is based was obtained from young fish trawl hauls between 3rd March and 17th October 1939. It consists of 778 young forms which have been systematically studied for the first time from Manx waters. They have been referred to 36 different species as seen from Table 37.

The specimens, preserved in formalin as soon as possible, were finally examined some months after their capture. By this time only the black pigment had survived the fixative, and references are therefore almost entirely concerned with the distribution of this pigment. Measurements of the young fish to the nearest quarter millimetre have been taken by means of fine dividers used in conjunction with a binocular microscope.

The account of the catch includes the chief characters with special reference to differentiating features, if any, vertical distribution and other points important to the particular species described. Some rearing experiments have been carried out with a view to confirming the identification of later stages and the results of these are included under the appropriate species.

The area of investigation, apparatus, and the material and methods have been already described in the first number of this series (Bal, 1943).

THE FISH LARVÆ

1. Clupea harengus (L)—Herring.

Table 1. Record of Cl. harengus.

Date	Depth in Metres	No.	Size in mm.
3- 5-39	5.4	4	10.0—11.5
12-10-39	6.8	1	11.75
17-10-39	5.4	1	10.75

All except one of these post-larvæ were in good condition and showed characteristics of young herrings, including the number of myotomes in the trunk region (47-48).

These are the first records of larval herrings from Manx waters although the adults occur in large quantities to the west and south-west of the Island and form an important fishery in the late summer and autumn. The off-shore fishing terminates in mid-September when the full herring have spawned, presumably on grounds to the south-west of the Island.

Evidence given so far in the literature (Smith 1938) points only to this autumn spawning of Manx herring, except that Hsueh (1939) did discuss the possibility of certain Age Group III fish examined in 1934-36 being spring spawners.

Four of the larvæ here described were caught in May and two in October, and all may be regarded as of the same age, when allowance is made for a different rate of growth, due to difference in sea temperature during development in the spring and autumn respectively. There is little doubt, therefore, that the two lots belong to different spawning stocks, the former from eggs spawned in the spring and the latter from those in the autumn.

2. **Clupea sprattus** (L)—Sprat.

Table 2. Record of Cl. sprattus.

Date	Depth in Metres	No.	Size in mm.
28-4-39	7.2	1	3.0
10-5-39	6.3	4	3.0—9.0
18-5-39	4.5	1	3.0
22-5-39	6.3	1	6.0
29-5-39	5.4	2	3.0—8.0
29-5-39	4.5	2	—

Eleven young sprats were obtained from six hauls of the young-fish trawl during April and May. Eight of this small collection were early larval forms with the yolk sac not exhausted ; the rest were post-larval stages. The young sprats were thus relatively much fewer in numbers than the eggs taken this season.

The larval sprats were easily identified, because being but newly hatched they were too small to be confused with the larval herrings. The three post-larvæ, two of which were damaged, resembled to a great extent herrings of about the same size. They had, however, about 37 myotomes in the trunk regions which identifies them as sprat (Lebour, 1921).

The sprat larvæ, hatched in plunger jars, were very transparent and active, often exhibiting wavy snake-like movements. They were very delicate and sensitive, and consequently a slight disturbance of any kind or a sudden rise in temperature proved fatal. Their yolk sac was completely absorbed at about 5.5 mm. and not at 5.0 mm. as found by Lebour (1921). The black pigment, present in the embryo, was almost lost at the time of the hatching.

3. **Clupea pilchardus** (Walbaum)—Pilchard.

Table 3. Record of Cl. pilchardus.

Date	Depth in Metres	No.	Size in mm.
3-5-39	5.4	1	9.5
29-5-39	6.3	1	10.0

The above specimens, not in good state, were at first identified as herring, but they were subsequently found to possess 44-45 and 41-42 trunk myotomes respectively. These numbers are low for the herring, high for the sprat, but agree more with those of the pilchard. The two clupeoids are accordingly described here as pilchard, although the identification may be considered provisional in the case of the smaller specimen.

It may be mentioned in this connection that an adult pilchard with well-developed gonads was caught in Port Erin at the beginning of May 1938. This certainly does suggest that the pilchard may occasionally spawn in the area.

4. **Nerophis lumbriciformis** Pennant—Worm Pipe Fish.

Table 4. Record of N. lumbriciformis.

Date	Depth in Metres	No.	Size in mm.
23-8-39	5.4	1	36.0
22-9-39	6.8	1	——

The above specimens, one damaged, were found in two young-fish trawl samples from outside the bay. The worm pipe-fish, noted as common in Port Erin Bay, is apparently scarce in the open area outside it.

The elongated body, carrying no caudal fin, is speckled with light brown chromatophores which may be described as arranged in transverse groups at intervals, especially in the caudal region. The dorsal fin consists of twenty-five fin rays, a number characteristic for the species.

5. Gadus callarias L—Cod.

Table 5. Record of G. callarias.

Date	Depth in Metres	No.	Size in mm.
18-4-39	5.4	4	4.0 — 5.0
18-4-39	7.2	7	4.0 —10.5
3-5-39	6.8	2	4.5
3-5-39	6.3	2	4.5
3-5-39	5.4	2	6.0 — 7.0
8-5-39	4.5	1	7.25 approx.
8-5-39	5.4	5	5.25— 8.5
8-5-39	6.3	5	5.0 — 9.0
10-5-39	4.5	9	5.0 — 9.0
10-5-39	5.4	4	5.0 — 8.0
10-5-39	6.3	1	12.0
18-5-39	4.5	2	9.25—10.0
18-5-39	5.4	10	6.0 —12.5
18-5-39	6.3	16	5.75— 9.25
22-5-39	5.4	10	6.25—14.25
22-5-39	6.3	1	7.0
26-5-39	5.4	1	8.0
26-5-39	6.3	4	9.0 —22.0
26-5-39	6.8	21	7.0 —15.0
29-5-39	5.4	18	7.0 —13.5
29-5-39	6.3	25	6.5 —19.0
29-5-39	4.5	10	6.0 —11.0
1-6-39	5.4	7	6.0 —19.0
1-6-39	6.3	6	6.5 — 9.75
2-6-39	6.8	2	6.5 — 7.5
14-6-39	6.6	13	8.0 —20.5
17-6-39	6.3	4	6.0 —18.5
17-6-39	6.8	5	7.0 —17.0
21-6-39	6.3	1	10.0
26-6-39	6.3	1	25.0
26-6-39	6.8	1	9.0
27-6-39	6.3	1	16.0

200 young cod, measuring 4.0—25.0 mm., were obtained with the fish trawl at various depths stated above. They, like the eggs, were thus common in this area and were abundant in May, that is about a month after the peak of the spawning.

The larval and the early post-larval stages can be recognised by their distinguishing characters, the three post-anal black pigment patches in particular. The patch near the tail end, though indistinct in some cases, is characteristic of cod (Schmidt, 1905) and is absent in allied species likely to be confused with it.

These black patches soon merge into one another and the body of the young cod is then covered with diffuse black chromatophores. Such later stages resemble to a great extent the pollacks of about the same size and the differentiation is thereafter difficult. It may be seen, however, that the body as well as the fins in the pollack is more densely coated with pigment than in the cod. In addition the difference in the number of the fin-rays helps in the final separation of the two forms.

Some cod larvæ, hatched in plunger jars, appeared fairly hardy and lost their yolk sac at 5.0 mm. or thereabout. They were devoid of yellow pigment and therefore easily separated from small whitings, from the same jars. It may be added here that the most posterior pigment patch of the larval cod consists of a few spots only and, in consequence, it has not the prominence figured by McIntosh and Masterman (1897).

6. **Gadus merlangus** L—Whiting.

Table 6. Record of C. merlangus.

Date	Depth in Metres	No.	Size in mm.
18-4-39	5.4	4	3.0
18-4-39	7.2	4	3.0
28-4-39	7.2	1	3.5
8-5-39	4.5	5	3.0—3.25
8-5-39	5.4	1	3.0
8-5-39	6.3	2	6.75
10-5-39	4.5	2	4.75
10-5-39	5.4	2	4.0 — 5.0
10-5-39	6.3	3	5.0
18-5-39	4.5	1	5.5
18-5-39	5.4	1	6.25
22-5-39	5.4	3	4.25— 9.0
22-5-39	6.3	2	3.0 — 6.25
26-5-39	6.8	1	3.0
29-5-39	5.4	4	5.5 — 7.75
29-5-39	6.3	7	4.5 — 7.0
29-5-39	4.5	1	—
1-6-39	6.3	3	5.0 — 6.0
2-6-39	6.8	1	5.25
14-6-39	6.6	1	8.75
17-6-39	6.3	1	5.25
17-6-39	6.8	1	6.75

51 young whiting—3.0 to 9.0 mm. in length, were recorded in the fish trawl from April to June, with the maximum in May. The period of their occurrence is thus in accordance with the observations on whiting eggs, which were abundant in April and disappeared early in June. Judging from the material in hand, the forms were found equally at the various depths sampled by the net.

The larval whiting were easily recognised by the vacuolated nature of the yolk and the later stages by the post-anal pigment, distinctly arranged into dorsal and ventral rows of black dots, on each side of the median fins. It may be noted also that young whiting are more transparent, thin and tender than the young of cod and pollack.

Whiting larvæ, hatched at the Port Erin Station, were characterised by the early appearance of yellow pigment and in addition black pigment was also present. The yolk sac was usually absorbed at about 4.0 mm., when the whole body, excepting the tip of the tail, appeared to be coated with black, giving the larva a peculiar appearance by means of which it could be distinguished even with the naked eye.

7. **Gadus pollachius** (L)—Pollack.

Table 7. Record of G. pollachius.

Date	Depth in Metres	No.	Size in mm.
26-5-39	6.3	1	5.75
29-5-39	6.3	1	6.5
1-6-39	6.3	2	6.25— 7.5
14-6-39	6.6	2	20.5 —28.0
26-6-39	5.4	1	29.5
27-6-39	5.4	5	22.0 —30.0
27-6-39	6.3	5	20.0 —29.0

Young pollack were few in this collection, only seventeen of them being found in the months of May and June at the above depths. They measure from 5.75 to 30.0 mm., although only four are below 7.5 mm., the rest of them being more than 20 mm. in length. A scarcity of the early post-larval stages of pollack has been also noted by Hefford (1910) and Clark (1914).

The smaller stages were differentiated from similar sized cods by the lack of pigment on the posterior part of the tail, and the bigger ones by means of the general density of black pigment and also by the position and the number of the fin rays.

8. **Molva molva** (L)—Ling.

Table 8. Record of M. molva.

Date	Depth in Metres	No.	Size in mm.
1-6-39	6.3	2	8.5—10.25

Only two post-larval ling were procured from a sample taken near the mouth of the Sound. The ling is not recorded as spawning in less than 90 metres of water and therefore it may be conjectured, in the present state of our knowledge, that these forms were carried in from the deeper water to the west of the Island.

The above specimens, being in good condition, can be determined with certainty by their very elongated and pigmented ventral fins, and also by the two black transverse bars on the tail.

9. **Onos mustela** (L)—The Five Bearded Rockling.

Table 9. Record of O. mustela.

Date	Depth in Metres	No.	Size in mm.
3-5-39	5.4	2	3.5 — 4.0
8-5-39	5.4	1	5.0
8-5-39	6.3	1	4.5
10-5-39	4.5	1	4.25
10-5-39	5.4	1	4.0
18-5-39	6.3	1	5.25
22-5-39	5.4	4	5.25— 6.0
22-5-39	6.3	3	4.75— 8.5
26-5-39	6.3	3	4.0 — 7.0
29-5-39	5.4	10	4.5 — 7.25
29-5-39	6.3	14	4.5 —10.0
29-5-39	4.5	5	5.25— 8.0
1-6-39	5.4	4	5.5 — 6.25
1-6-39	6.3	7	4.0 — 7.0
2-6-39	6.8	3	4.75— 7.0
14-6-39	6.6	1	12.0
26-6-39	5.4	3	7.5 —10.5
27-6-39	5.4	1	17.5
27-6-39	6.3	1	6.5

66 specimens of the five bearded rockling were found in May and June, but chiefly in May, *i.e.*, some time after the maximum occurrence of eggs. Most of them are post-larval forms ranging from 3.5 to 17.5 mm. in length. The rockling fry, according to these records, occur on the whole in the upper layers of water; this agrees with the conclusions of Russell (1926).

The larvæ can be identified by three black pigment zones in the post-anal region and the post-larvæ by their pigmented ventral fins, in particular. The fins considerably increase in length during the course of development and the pigment is mostly confined to the posterior portion. The older forms are, besides, characterised by their silvery sheen, very bright in living specimens.

The rockling larvæ hatched in plunger jars were so tiny that they were detected with some difficulty in spite of their characteristic pigment. 55 of them—about 3.0 mm. in size after fixation, were examined for verification, and all, excepting two, belonged to *O. mustela.* The remaining two, however, possessed only two post-anal zones of black pigment, a pattern peculiar to *O. cimbrius.* This confirms the finding of the four bearded rockling eggs in this area (Bal, 1943).

10. **Labrus bergylta** (Ascanius)—Ballan Wrasse.

Table 10. Record of L. bergylta.

Date	Depth in Metres	No.	Size in mm.
29-5-39	6.3	2	6.0 —6.25
29-5-39	4.5	2	5.0 —7.25
1-6-39	5.4	5	5.0 —5.5
1-6-39	6.3	2	4.75—6.0
17-6-39	6.3	1	5.75
26-6-39	6.8	2	6.0 —6.5
19-7-39	7.2	1	5.5

15 post-larval wrasse—measuring 4.75 to 7.25 mm. in a preserved state, were taken with the fish trawl during May, June and July. All of them are ascribed to the Ballan Wrasse, according to the key for the identification of the post-larval wrasses by Ford (1922). It may be noted that in a few specimens the head pigment is continued on the neck and so there was deeper pigmentation in this region than illustrated by Ford. In addition it may be pointed out that the pigment on the anal fin occasionally varies in extent ; in one case it is found only on one or two interradial membranes while in another nearly half of the fin is pigmented.

The young of *L. bergylta* and *Lebetus scorpioides* look rather alike to an untrained eye by reason of the following common characters :—(a) Anus approximately at the mid point of the body, (b) Part of the hindermost end of the tail devoid of pigment and (c) Pigment on the anal fin. A critical examination, however, reveals that the body of *L. bergylta* is deeper and more advanced in development than specimens of *Lebetus scorpioides* of the same length. In addition the young of the latter have large chromatophores, which extend to some extent towards the hinder part of the tail, especially along the median ventral line, instead of ceasing rather abruptly behind the anal fin as they on in *L.*

11. **Ammodytes lanceolatus** Lesauvage—Greater Sand-Eel.

Table 11. Record of A. lanceolatus.

Date	Depth in Metres	No.	Size in mm.
26-6-39	6.8	1	8.5
27-6-39	5.4	1	10.5
14-7-39	5.4	1	10.0
14-7-39	7.2	1	12.0
19-7-39	7.2	2	10.0—12.0
1-8-39	7.2	2	7.25— 7.5
1-8-39	5.4	1	8.0
23-8-39	6.8	1	—

10 post-larvæ (7.25—12 mm.) of *A. lanceolatus* occurred in these samples during the summer of 1939. The small number tends to show that this species is less common than *A. tobianus* in these waters. The first specimen appeared in June, which indicates that spawning might have commenced in May and not in June as at Plymouth (Clark, 1920). Most of these few larvæ were found in the deeper hauls, so that there are indications of a preference for water of greater depth.

The species was chiefly determined by the long upper jaws with teeth and two dorsal pre-caudal black chromatophores, and also by other features noted by Ford (1920). In one specimen the two dorsal caudal spots were augmented by a third small one.

12. **Ammodytes tobinus** L—Lesser Sand-Eel.

Table 12. Record of A. tobianus.

Date	Depth in Metres	No.	Size in mm.
3-3-39	—	2	—
24-3-39	6.3	6	5.0— 6.0
6-4-39	—	11	7.0
18-4-39	5.4	8	7.0—10.0
18-4-39	7.2	8	9.0—13.5
3-5-39	6.3	1	14.0
3-5-39	5.4	3	7.5—12.5
5-5-39	5.8	1	—
29-5-39	4.5	2	11.0—13.0
26-6-39	6.3	1	6.0
27-6-39	5.4	2	10.0—11.0
14-7-39	5.4	1	7.0
14-7-39	7.2	1	6.0
19-7-39	6.3	2	6.5— 7.0
1-8-39	6.8	2	—
1-8-39	5.4	1	—

52 young—mostly post-larvæ—of the lesser sand-eel were noted as above in 1939. They were amongst the earliest larvæ of the season and occurred first on March 3rd and last on August 1st. They were approximately from 5.0 mm. to 14.0 mm. in length and even those found in August were small in size and comparatively young. It is therefore evident that *A. tobianus* unlike *A. lanceolatus* has a prolonged spawning time of at least seven months in Manx waters. At Plymouth, according to Clark (1920), the spawning commences perhaps in December and ends in August.

These specimens were on the whole more pigmented than those of *A. lanceolatus*, the most distinguishing feature being a row of black chromatophores on the dorsal side of the posterior end of the tail. They were besides characterised by the toothless and short upper jaw and by other features described by Ford (1920).

13. **Gobius niger** L.—Black Goby.

Table 13. Record of G. Niger.

Date	Depth in Metres	No.	Size in mm.
5-4-39	6.3	1	3.0
26-4-39	7.2	1	2.5
3-5-39	6.3	1	4.0
5-5-39	5.8	1	5.5
29-5-39	4.5	1	6.0
1-6-39	5.4	1	4.5
14-6-39	6.6	14	4.0—10.0
17-6-39	6.3	3	4.0— 8.5
17-6-39	6.8	4	4.0— 6.5
21-6-39	5.4	1	9.0
26-6-39	5.4	1	—
26-6-39	6.3	11	3.5— 9.0
26-6-39	6.8	26	3.0— 7.5
27-6-39	5.4	1	8.0
3-7-39	5.4	1	10.0
19-7-39	7.2	1	10.0
1-8-39	7.2	2	8.0— 8.75

The fry of six species of Gobius, the adults of only four of them being mentioned in the Isle of Man Fauna, were caught in the young-fish trawl during the season under review. In addition there were young stages of *Lebetus scorpioides* and *Crystallogobius Nilssoni.*

G. niger was most common amongst them, being represented by 71 specimens, caught between April and August, with maximum numbers in June. They were from 2.5 to 10.0 mm. in length, but the early stages were few and it may be that the larvæ do not rise to the upper waters until further development takes place. Those, nearing 10.0 mm. in length, were the largest and best developed in this collection, and the absence of older stages suggests that they may have moved towards the bottom. It may also be seen from the above table that all excepting seven specimens occurred at depths below six metres.

The smaller stages of *G. niger* were identified by the number of vertebræ and the prominent air bladder, and the bigger ones by the pigmentation, especially of the distinctive dorsal caudal chromatophore, as

well as by some other features described by Petersen (1917 & 1919) and Lebour (1919). In a few cases the dorsal chromatophore was supplemented by a second very small one, situated immediately in front. It was also true in the present case that the young of *G. niger* were more advanced in general development than the similar sized forms of *G. minutus*, a feature often useful in differentiation.

14. **Gobius Ruthensparri** Euphras—Spotted Goby.

Table 14. Record of G. Ruthensparri.

Date	Depth in Metres	No.	Size in mm.
26-6-39	5.4	1	3.5
1-8-39	7.2	1	11.0

Only one specimen of *G. Ruthensparri* was obtained in June and a second in August. The first—3.5 mm.—could be distinguished in particular by the two dorsal caudal chromatophores, one situated nearly above the anus and the other further behind.

Dominating features in the post-larval stage of 11.0 mm. are a chromatophore below the auditory vesicle and the large eyes compared with some other species. It has in addition a short upper jaw. Other features are pointed out by Petersen (1917 & 1919) and Lebour (1919). It may be stated that the particular specimen under examination does not possess the amount of vertebral pigment depicted by Petersen ; on the contrary it resembles very closely Plate III, Fig. 14, by Lebour (1919).

15. **Gobius elongatus** Canestrini.

Table 15. Record of G. elongatus.

Date	Depth in Metres	No.	Size in mm.
26-6-39	6.3	1	11.25

The single post-larva of *G. elongatus*, a goby not recorded previously from the Isle of Man, has an elongated and thin body, sparsely pigmented along the ventral line. It has a small eye—0.54 mm. across, 32 vertebræ and 11 fin-rays both in the second dorsal and anal fins. Lebour (1919) has also noted a similar number of fin-rays for Irish specimens of this species, although there are 9-10 in Plymouth forms.

It carries, besides, a chromatophore, behind and above the anus, a feature commonly associated with *G. pictus*, but Lebour has also observed it occasionally in *G. elongatus. G. Pictus*, however, never has more than 30 vertebræ, so that the present specimen may be assigned to *G. elongatus* with confidence.

16. **Gobius pictus** Malm—Painted Goby.

Table 16. Record of G. pictus.

Date	Depth in Metres	No.	Size in mm.
1-8-39	7.2	1	5.5
1-8-39	6.8	1	3.5

Two specimens of *G. pictus* occurred on August 1st, in two fish-trawl hauls at the mouth of the Calf Sound. They have a thin body with a very transparent and oval air bladder and 30 vertebræ.

The younger of the two is smaller than any recorded by Lebour (1919) at Plymouth and it resembles Figure 11, Plate I, by Petersen (1919), especially in possessing 4 or 5 upper caudal chromatophores. In the other specimen the chromatophore situated behind the anal fin is enlarged by the ramifications of the pigment but that found behind and above the anus is less prominent than is figured in the literature. The fin-rays have begun to show even in these small forms.

17. **Gobius minutus** Pallas—Freckled Goby.

Table 17. Record of G. minutus.

Date	Depth in Metres	No.	Size in mm.
17-6-39	6.3	1	8.0
21-6-39	6.3	5	6.5—14.0
26-6-39	6.8	4	4.0— 9.0
27-6-39	5.4	1	8.5
27-6-39	6.3	3	8.5—11.0
3-7-39	5.4	1	7.0
3-7-39	6.8	4	8.5—10.0
19-7-39	5.4	1	10.0

The above 20 young stages of *G. minutus*, a new addition to the Manx Fauna, were obtained from these samples during June and July. They measure 4.0—14.0 mm. in length and the smallest one is younger than that noted by Lebour (1919) at Plymouth.

They are characterised by a highly ramified lower caudal chromatophore. The ramifications may, in a few cases, reach a small upper caudal chromatophore which is not only present in the majority of the specimens but may be occasionally augmented by a secondary smaller chromatophore. In counts that were made the number of vertebræ and fin-rays were typical of the species.

The slender post-larvæ of *G. minutus* seem to pass into deeper water at a bigger size than *G. niger*.

18. **Gobius Jeffreysi** Gunther—Jeffrey's Goby.

Table 18. Record of G. Jeffreysi.

Date	Depth in Metres	No.	Size in mm.
26-5-39	6.3	1	6.75
1-6-39	5.4	1	8.5
1-6-39	6.3	1	8.25

Three young stages of this goby, of which a single adult has been recorded in Manx waters, were secured from three separate hauls in the vicinity of the Calf Sound and off the Charran.

They are so very peculiarly pigmented that their identification is beyond any confusion. The pigment, comprising large brownish-black chromatophores, is chiefly distributed in a continuous and prominent row on the dorsal and ventral side of the post-anal portion. The chromatophores are even more ramified than depicted by Lebour (1919).

19. **Lebetus scorpioides** (Collet).

Table 19. Record of Lebetus scorpioides.

Date	Depth in Metres	No.	Size in mm.
18-5-39	5.4	1	5.0
1-6-39	6.3	1	5.0
14-6-39	6.6	1	8.0
26-6-39	6.3	1	6.5
26-6-39	6.8	1	7.0
3-7-39	6.8	1	5.25
19-7-39	7.2	1	3.5
19-7-39	6.3	1	5.75

Eight specimens of *Lebetus scorpioides* were found in these hauls at depths mostly below six metres. This is certainly an important record because, besides being the first for this area, there are very few records of the early stages of this species from any other area. Petersen (1919), however, has given three figures of young forms between 3.5 and 5.5 mm. and some of the above specimens are very similar to the figures.

In the smallest stages under examination the light black chromatophores are arranged into a dorsal and a ventral row, the former extending on to the head ; but soon the pigment spreads over most of the body, excepting the hindermost part of the tail and the tail fin. The later stages, being thus densely pigmented, assume a peculiar pattern, quite unlike anything found in the other Gobioidea discussed here. The vertebræ and fin-rays are, besides, within the characteristic numbers for the species.

nguishing features between the young of *Labrus bergylta* and *scorpioides* have already been dealt with in earlier pages, but it may e added that the latter can be separated from the former by its rent air-bladder.

The absence of forms beyond 8.0 mm. in this collection may be due to the fact that the adult being small, larvæ about that length have already gone to the bottom.

20. **Crystallogobius Nilssoni** (V. Düben & Koren).

Table 20. Record of Crystallogobius Nilssoni.

Date	Depth in Metres	No.	Size in mm.
1-8-39	5.4	1	5.25

This larva of *Crystallogobius Nilssoni*, a form new to the Manx Fauna, was procured in a haul from near the Calf Sound. It is only 5.25 mm. in length, while the smallest specimen recorded from Plymouth by Lebour (1919) was about 9.0 mm.

Unlike most of the gobies discussed here, it bears very little pigment, this being confined to the eye, the air-bladder, a single spot on the tip of the lower jaw, and a single lower caudal chromatophore. The latter, situated near the posterior extremity of the anal fin, is absent from a later stage described by Lebour, as well as the lower jaw spot. This, however, is described by Petersen (1919) under *Crystallogobius linearis*. (Syn. with *Crystallogobius Nilssoni*.)

The present specimen is determined, also, by the vertebral number (30) and by elongated second dorsal and anal fins, although these are not well developed.

21. **Callionymus lyra** L.—Dragonet.

Table 21. Record of C. lyra.

Date	Depth in Metres	No.	Size in mm.
22-5-39	6.3	1	4.0
26-5-39	5.4	1	6.5
29-5-39	5.4	1	5.0
29-5-39	6.3	7	4.0—5.25
29-5-39	4.5	2	4.5—5.25
1-6-39	6.3	1	4.0
17-6-39	6.3	1	6.5
17-6-39	6.8	2	6.0
26-6-39	6.3	1	8.0
26-6-39	6.8	1	4.0
3-7-39	5.4	1	10.0
3-7-39	6.8	1	9.5

Twenty dragonets, the majority being post-larvæ, appeared in the fish trawl samples on the dates mentioned above. Twelve of them occurred in May, that is about a month after the peak of the spawning season as stated in the previous paper. They were taken from depths of 4.5—6.8 metres, but as the catches were small it is not possible to make a definite statement upon the vertical distribution of dragonet larvæ.

There is little doubt that they all belong to *C. lyra*, because *C. maculatus* had hardly commenced spawning this season at the time these larvæ had reached their maximum occurrence. The specimens have a large head and abdomen, with a narrowed or tapering tail. They also possess a characteristic beaklike mouth and spines on the operculum, particularly in older stages (McIntosh & Prince, 1890). The body is covered with brownish-black chromatophores, most abundant on the ventral side of the abdomen. In later stages the chromatophores, lying on the ventral side of the abdomen and the tail, develop into brown reticulations which give an effect of a fairly even mosaic pattern, a feature that has not received sufficient notice previously. Lastly the fins are devoid of pigment except that the fleshy base of each pectoral is covered with a few chromatophores.

The little dragonet larvæ, hatched in plunger jars, moved about somewhat in a darting manner and exhibited a rather striped appearance to the naked eye. The larva was about 2.0 mm. long on hatching and 3.0 mm. at the time of the complete absorption of yolk.

22. **Blennius pholis** L.—Shanny.

Table 22. Record of B. pholis.

Date	Depth in Metres	No.	Size in mm.
21-6-39	5.4	1	6.25

The pelagic stages of *B. pholis* were wanting in outside samples but one was taken in the only drag made with a young-fish trawl inside the bay.

This species is specially characterised by an elongated and deeply pigmented pectoral fin and by other features described by Ford (1922). The particular specimen had, in addition, a few more small spots towards the posterior ventral end of the tail than figured by Ford for Plymouth specimens.

23. **Trigla gurnardus** L.—Grey Gurnard.

Table 23. Record of T. gurnardus.

Date	Depth in Metres	No.	Size in mm.
26-4-39	7.2	1	—
22-5-39	5.4	1	7.5
22-5-39	6.3	1	6.5
26-5-39	6.3	3	6.0 —11.0
29-5-39	5.4	17	5.0 —10.0
29-5-39	6.3	13	4.75—10.75
29-5-39	4.5	6	6.0 —10.0
1-6-39	5.4	2	6.5 —12.5
1-6-39	6.3	5	6.25— 7.25
2-6-39	6.8	1	7.5
14-6-39	6.6	1	13.5
17-6-39	6.8	1	22.5
14-8-39	6.8	1	21.5

53 specimens of *T. gurnardus* occurred in this collection from April to August (July excepted) but mainly in May. They were found at all depths of water sampled by the young-fish trawl.

The early stages are distinguished by their shape and pigment, but particularly by the large pectoral fins. The latter, as development proceeds, become much more prominent and elongated, and partially pigmented on the posterior portion. The late stages have, in addition, the large spiny head and elongated snout typical of the gurnard.

The specimen of June 17th (22.5 mm. in length) differs from the rest in having the pectoral fins deeply pigmented as described by Clark (1914) for *T. hirundo*. The fins instead of being broad and short like those of *T. hirundo*, however, are very similar in this respect to those of *T. gurnardus*. The adult *T. hirundo* is of rare occurrence in this area and moreover is rather too late a spawner for the larvæ to be so large in June. Therefore this particular form is also ascribed to *T. gurnardus* in spite of differences in the quantity of pigment, ascribed to individual variation.

A few grey gurnards were successfully hatched in plunger jars and were about 5.0 mm. on emergence. Upon examining seven of them, ranging from 5 to 5.5 mm. in length in a preserved condition, it was found that although the anus is gadoid in position, it is also partially drawn out towards the margin of the ventral fin as in the Pleuronectids.

24. **Cottus scorpius** L.—Short-Spined Sea-Scorpion.

Table 24. Record of C. scorpius.

Date	Depth in Metres	No.	Size in mm.
6-4-39	—	4	6.5—8.0
3-5-39	6.3	1	9.0

Five post-larvæ of *C. scorpius* were obtained as above. They were separated from the young of *C. bubalis*, particularly by the extension of the dorsal black pigment behind the head and also immediately beyond the anus (Holt, 1893).

In May 1939 some eggs of this fish hatched out when being carried from Port St. Mary to Port Erin Biological Station but there were no more hatchings for a time after the eggs had been placed into plunger jars. It had probably been stimulated by the jolting given during the journey and the rising temperature of water. On another occasion some eggs were left in a jar containing a small quantity of water and exposed to sunshine, and others from the same catch put into a plunger jar; the former commenced to hatch out before the latter, again due to the higher temperature.

25. **Cottus bubalis** Euphrasen—Long-Spined Sea-Scorpion.

Table 25. Record of C. bubalis.

Date	Depth in Metres	No.	Size in mm.
18-4-39	5.4	1	5.5
3-5-39	6.8	1	4.5
3-5-39	6.3	2	5.0
3-5-39	5.4	1	4.5
10-5-39	5.4	1	9.0
2-6-39	6.8	1	8.5

Seven pelagic young of *C. bubalis* were taken in these samples between April and June. The smallest larva obtained had some dots ventrally on the tail behind the anus whereas Holt (1893) states that such marks are entirely lacking. It may be stated in general that the larvæ of *C. bubalis* are smaller in size and less pigmented than those of *C. scorpius.*

26. **Cottus lilljeborgi** Collet—Norway Bullhead.

Table 26. Record of C. lilljeborgi.

Date	Depth in Metres	No.	Size in mm.
8-5-39	4.5	1	8.0
8-5-39	6.3	1	9.0
18-5-39	4.5	1	11.75

Three post-larvæ of *C. lilljeborgi*, a species very rarely recorded in British waters and for the first time in Manx waters, were secured with the young-fish trawl this season.

This marked absence of past records is very likely due to the inclusion of such larvæ under allied species, *C. bubalis* in particular. The general disposition of their larval pigment is similar to that of *C. bubalis* and naturally gives rise to possible confusion. The two species can be distinguished, however, with certainty by a close examination of the chromatophores covering the abdominal area. They occur in short, closely packed stripes in *C. lilljeborgi* and are diffuse and stellate in *C. bubalis* (Bruun, 1925).

Further, the above specimens possess fin-rays similar to the number quoted by Gunther (1889) for Norway Bullhead from the North-West Coast of Scotland. They are, therefore, assigned to *C. lilljeborgi* and the writer agrees with Bruun and Gunther in including this species in the British *Cottidae.*

27. **Agonus cataphractus** L.—Pogge.

Table 27. Record of A. cataphractus.

Date	Depth in Metres	No.	Size in mm.
26-5-39	6.3	1	10.0

This pelagic young of *A. cataphractus*, noted as rare round the Island, was identified by the general appearance of head, anus and fins in particular (McIntosh & Prince, 1890). It was, besides, pigmented with black stellate chromatophores on body and fins as illustrated by Schmidt (1908).

28. **Cyclopterus lumpus** L.—Lump-Sucker.

Table 28. Record of C. lumpus.

Date	Depth in Metres	No.	Size in mm.
10-5-39	5.4	1	6.5

The body of this tadpole-like larval lump-sucker is coated with numerous brownish spots, excepting on the tip of the tail and marginal fins. The paired fins—the pectorals placed in a ventro-lateral position and the pelvics forming the sucker are well developed even at this small size. The eyes are, besides, large and deeply pigmented.

29. **Liparis vulgaris** Flem.—Common Sea Snail.

Table 29. Record of L. vulgaris.

Date	Depth in Metres	No.	Size in mm.
24-3-39	6.3	1	5.0
28-4-39	7.2	2	5.0

These three larvæ of the Common Sea Snail occurred in the fish-trawl hauls, outside the mouth of Port Erin Bay. To a beginner they may appear somewhat like those of *C. bubalis* owing to their partial resemblance in the distribution of the pigment, but soon the differences in the shape, size and the pectoral fins become evident.

They carry black chromatophores on the peritoneum and in a faint line along the ventral side of the tail. The pectoral fins are pigmented only along the basal portion and in this respect they differ from *L. montagui*, and it is thus a feature useful in differentiating the two. The marginal fins show the presence of fin-rays even in these 5.0 mm. stages,

30. Pleuronectes platessa L.—Plaice.

Table 30. Record of P. platessa.

Date	Depth in Metres	No.	Size in mm.
3-3-39	—	1	9.0
5-4-39	6.3	5	—
6-4-39	—	1	—
18-4-39	5.4	16	7.0 —10.0
18-4-39	7.2	11	6.0 —10.5
28-4-39	7.2	1	7.0 —
3-5-39	6.8	6	5.0 — 6.5
3-5-39	6.3	1	6.0 —
3-5-39	5.4	5	6.0 — 7.0
5-5-39	5.0	1	—
5-5-39	5.8	1	6.5
8-5-39	4.5	2	5.25— 7.0
8-5-39	5.4	2	5.5 — 8.0
8-5-39	6.3	3	7.0 — 9.25
10-5-39	4.5	2	7.0
10-5-39	5.4	2	7.25—10.0
18-5-39	4.5	1	7.0
18-5-39	6.3	4	6.25—10.0
22-5-39	5.4	10	7.0 —12.5
22-5-39	6.3	12	6 5 —10.5
26-5-39	6.3	1	—
26-5-39	6.8	4	5.5 —12.0
29-5-39	5.4	9	7.5 —14.0
29-5-39	6.3	5	7.0 —15.75
29-5-39	4.5	3	7.0 —11.0
1-6-39	5.4	3	8.0 —14.75
1-6-39	6.3	6	5.5 —10.0
2-6-39	6.8	3	—
14-6-39	6.6	1	13.5
17-6-39	6.3	1	6.5

The plaice fry, comprising 123 specimens, stand next to cod in the total number caught. The capture of a large number of small young ones in the push net worked on Port Erin beach is additional evidence of their abundance around Port Erin.

This material—measuring 5.0—15.75 mm. in formalin—was taken from March to June but principally in May, a period falling some time after the maximum occurrence of eggs. Regarding their vertical distribution it will be seen from above that they commonly occur at the various depths worked by the young-fish trawl.

The larvæ and the post-larvæ can be identified particularly by the pigment, the disposition of which has been fully described and drawn in the literature (Fullarton, 1891). The larval forms seem to be delicate since they were often damaged or deformed when taken from the net.

It may be added in this connection that some plaice larvæ were reared in plunger jars and were fed with fine plankton organisms, diatom or dinoflagellate cultures, nauplius and echinus larvæ. It was observed in this connection that the larvæ usually tried to avoid bright sunlight by resorting to the bottom of the jars ; but they moved about freely when the intensity of light was reduced by shading the windows and covering the jars with black paper.

31. **Pleuronectes microcephalus** (Donovan)—Lemon Sole.

Table 31. Record of P. microcephalus.

Date	Depth in Metres	No.	Size in mm.
27-6-39	6.3	1	14.5

A single good specimen of post-larval lemon sole was found in a haul near Calf Island. It has a deep body with small head and the marginal fins closely approaching the caudal (Petersen, 1904). It has also the characteristic patches of black pigment and number of fin-rays.

It may be stated here that 75 lemon sole larvæ, which measured 5.c—7.0 mm. after preservation in formalin, were hatched out and easily reared in plunger jars for about three weeks after the yolk sac had been absorbed. They were very active and could be easily picked out in the jars by means of their characteristic pigment pattern. The original greenish-yellow patches of pigment assumed a rather dark appearance by the addition of touches of black in the course of development.

It was found during this study that the young lemon soles are hardier than the plaice and thus more suitable for rearing under artificial conditions.

32. **Pleuronectes cynoglossus** (L.)—Witch.

Table 32. Record of P. cynoglossus.

Date	Depth in Metres	No.	Size in mm.
29-5-39	5.4	1	12.0
29-5-39	4.5	1	14.0
1-6-39	5.4	1	11.25
1-6-39	6.3	1	8.0

The young witches consist of four post-larvæ, taken near the Calf Sound, in the neighbourhood of which adults have been noted.

They have a thin and elongated post-anal body, with a comparatively large head and projecting abdomen. They are also characterised by three prominent transverse black stripes, with three smaller alternating ventral groups. Other distinguishing features are described by Williamson (1904).

33. **Solea vulgaris** (Quensel)—Sole.

Table 33. Record of S. vulgaris.

Date	Depth in Metres	No.	Size in mm.
1-6-39	6.3	1	8.0

A good specimen of post-larval sole occurred in a haul at the mouth of the Calf Sound. It has a peculiar short blunt head with small blue eyes and a deep body, with the posterior end bearing some caudal-rays turned upwards. It is, besides, speckled all over with brownish, branched chromatophores.

It may be mentioned here that ten sole larvæ, size in formalin 3.75 to 5.0 mm., were reared in a plunger jar for confirming the identification of sole eggs. They were about 4.0 mm. on hatching. The larvæ, though often on the move, appeared to keep more towards the bottom of the jar.

34. **Lepadogaster deCandolii** Risso.—Connemara Sucker.

Table 34. Record of L. deCandolii.

Date	Depth in Metres	No.	Size in mm.
19-7-39	6.3	1	6.0

One *L. deCandolii* larva, only occasionally referred to in the literature was procured from a fish-trawl haul a mile off Port Erin Breakwater.

Unlike the other two common species of Lepadogaster, it is much less pigmented and has a distinct row of small black chromatophores along the upper side of the alimentary canal, a feature apparently peculiar to the species. This is illustrated by Smith (1888) but not described. Small black chromatophores are also seen on the head and a few more on the ventral post-anal part of the body.

35. **Lepadogaster bimaculatus** Pennant, Guitel—Two-Spotted Sucker.

Table 35. Record of L. bimaculatus.

Date	Depth in Metres	No.	Size in mm.
17-6-39	6.3	1	6.5
17-6-39	6.8	2	5.75 —6.5
26-6-39	6.3	2	5.0 —6.0
27-6-39	6.3	1	8.5
1-8-39	7.2	2	6.25—7.0
1-8-39	6.8	1	5.5
1-8-39	5.4	1	4.5

Ten pelagic young of *L. bimaculatus* occurred in the hauls, taken at the depths recorded above. They differ from the young of *L. gouani* in having less intense black pigment and particularly in being devoid of it on the flattened dorsal side of the head and body, a feature very useful in differentiation of preserved specimens. The sides of the body, excepting a small posterior portion of the tail, are covered with small black dots, apparently distributed in four rows in addition to a few spots lying between. The larvæ are also determined by the prominent anus, and by the short stumpy pectoral fins. Other details may be gathered from Holt (1891) and McIntosh (1896).

Some two-spotted sucker eggs, attached to a bivalve shell, were found in the catch of a dredge taken at seventeen fathoms outside the bay on May 30th, 1939. The hatched larvæ, ranging from 4.5 to 6.0 mm. in formalin, showed the peculiar absence of black pigment on the dorsal side which has already been noted for the fish trawl specimens.

36. **Lophius piscatorius** L.—Angler Fish.

Table 36. Record of L. piscatorius.

Date	Depth in Metres	No.	Size in mm.
14-7-39	7.2	1	—

This young angler, being rather twisted, is not in a condition for exact measurement. Its short head and trunk is pigmented, but not the elongated tail. The filamentous pelvics, situated slightly in front and ventral to the pectorals, are less pigmented than in the specimen illustrated by Lebour (1925), but in agreement with the figure reproduced by Allen (1917). It is possible, however, that the amount of pigment has been reduced in the fixative.

Table 37. Monthly Summary of the Occurrence of Fish Larvæ in Young-Fish Trawl, Port Erin, 1939.

Month	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Total No. of Larvæ per Species
No. of Hauls	0	3	3	6	23	13	7	13	9	4	9	5	
C. harengus	..	..	..	..	4	..	..	..	..	2	..	..	6
C. sprattus	..	..	..	1	10	..	..	..	..	..	..	..	11
C. pilchardus	..	..	..	..	2	..	..	..	..	..	..	..	2
N. lumbriciformis	..	..	..	..	..	..	..	1	1	..	..	..	2
G. callarias	..	..	..	11	149	41	..	..	..	..	..	..	201
G. merlangus	..	..	..	9	35	7	..	..	..	..	..	..	51
G. pollachius	..	..	..	..	2	15	..	..	..	..	..	..	17
M. molva	..	..	..	..	..	2	..	..	..	..	..	..	2
O. mustela	..	..	..	..	46	20	..	..	..	..	..	..	66
L. bergylta	..	..	..	..	4	10	1	..	..	..	..	..	15
A. lanceolatus	..	..	..	..	..	2	4	4	..	..	..	..	10
A. tobianus	..	..	8	27	7	3	4	3	..	..	..	..	52
G. niger	..	..	..	2	3	62	2	2	..	..	..	..	71
G. Ruthensparri	..	..	..	..	..	1	..	1	..	..	..	..	2
G. elongatus	..	..	..	..	..	1	..	..	..	..	..	..	1
G. pictus	..	..	..	..	..	..	..	2	..	..	..	..	2
G. minutus	..	..	..	..	..	14	6	..	..	..	..	..	20
G. Jeffreysii	..	..	..	..	1	2	..	..	..	..	..	..	3
Lebetus scorpioides	..	..	..	..	1	4	3	..	..	..	..	..	8
Crystallogobius Nilssoni	..	..	..	..	..	..	..	1	..	..	..	..	1
C. lyra	..	..	..	..	12	6	2	..	..	..	..	..	20
B. pholis	..	..	..	..	..	1	..	..	..	..	..	..	1
T. gurnardus	..	..	..	1	41	10	..	1	..	..	..	..	53
C. scorpius	..	..	..	4	1	..	..	..	..	..	..	..	5
C. bubalis	..	..	..	1	5	1	..	..	..	..	..	..	7
C. lilljeborgi	..	..	..	..	3	..	..	..	..	..	..	..	3
A. cataphractus	..	..	..	..	1	..	..	..	..	..	..	..	1
C. lumpus	..	..	..	..	1	..	..	..	..	..	..	..	1
L. vulgaris	..	..	1	2	..	..	..	..	..	..	..	..	3
P. platessa	..	..	1	34	74	14	..	..	..	..	..	..	123
P. microcephalus	..	..	..	..	..	1	..	..	..	..	..	..	1
P. cynoglossus	..	..	..	..	2	2	..	..	..	..	..	..	4
S. vulgaris	..	..	..	..	..	1	..	..	..	..	..	..	1
L. deCandolii	..	..	..	..	..	..	1	..	..	..	..	..	1
L. bimaculatus	..	..	..	..	..	6	..	4	..	..	..	..	10
L. piscatorius	..	..	..	..	..	..	1	..	..	..	..	..	1
Total No. of Larvæ per Month	0	0	10	92	404	226	24	19	1	2	0	0	778

SUMMARY

1. 778 fish larvæ, ascribed to thirty-six species, have been systematically studied for the first time from Manx waters in this section *vide* Table 37. They were obtained with a half-sized young-fish trawl.

2. Fish larvæ were found from March to October—principally in May and June. They were absent in catches from November to February.

3. In addition to pigmentation, fin-rays, etc., the position of the anus in the length of the body has been found very useful in assigning the larvæ to the principal groups of fishes.

4. The larvæ of many species described in this paper are recorded from this area for the first time, and the following are notable amongst them :—*Cl. harengus*, *Cl. pilchardus*, *M. molva*, *Lebetus scorpioides*, *C. lilljeborgi*, and *L. deCandolii.*

5. The young stages of Cod, Whiting, Five Bearded Rockling, Lesser Sand Eel, Black Goby, Grey Gurnard and Plaice are well represented in these catches. Some of them reach their maximum number at times a month or so after the peak of the spawning.

6. The presence of Herring larvæ in May is evidence of a spring spawning in Manx waters in addition, to the regular autumn one.

7. The Sprat larvæ, hatched in plunger jars, were found to be very delicate and sensitive and were easily affected by any kind of slight disturbance.

8. The specimens of Pilchard also suggest its occasional spawning in this neighbourhood.

9. *A. tobianus*, the larvæ of which occur over a prolonged period, is more common than *A. lanceolatus* in Manx waters.

10. The young forms of *G. niger* are the commonest amongst the gobies recorded here.

11. The older stages of the Dragonet were characterised by having their ventral chromatophores arranged into a mosaic pattern.

12. The capture of well-defined specimens of *C. lilljeborgi* is additional evidence for their inclusion in British Cottidae as originally proposed by Bruun.

13. The hatched larvæ of Plaice showed a tendency to avoid strong sunlight by going to the bottom of the jars.

14. The observations from the hatching and rearing of Lemon Sole larvæ show their suitability for artificial hatching.

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A NEW CYSTOPUS SPECIES FOUND ON CARDAMINE SUBUMBELLATA (HOOK. F. AND T. ANDERS)

By

V. P. Damle,

Fergusson College, Poona

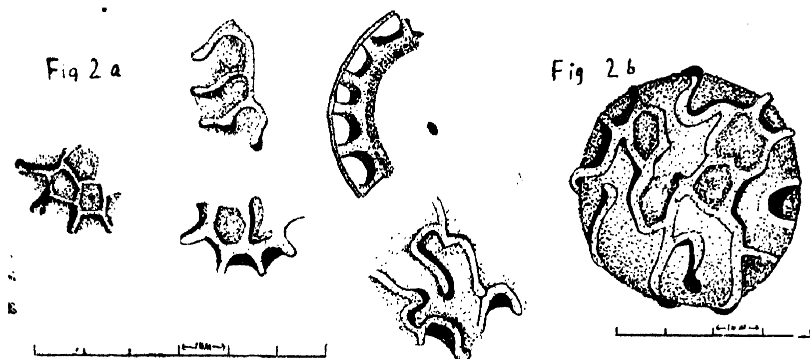
During the search for the material of *Cystopus platensis* (Speg.) in connection with his work on the cytology of *C. platensis* the writer (Damle, 1943) had come across *Cardamine subumbellata* plants infected by the "white rust." *Cystopus candidus* (Pers.) occurs usually on the Cruciferous plants and a few species of Cardamine are already on record as its hosts—*C. capensis* L., *C. africana* Th. (Wakefield, 1927). The Cystopus on *Cardamine subumbellata* was therefore, at first, taken to be *C. candidus* and this assumption was thought to be corroborated when a superficial examination showed tuberculate epispore of *Cystopus candidus*. The spore measurements also showed a general agreement with those of *C. candidus*. In Table I are given the measurements of the typical *C. candidus* and of the new form for easy comparison.

A careful study of the fungus, however, revealed some interesting points hitherto unsuspected and, therefore, a critical re-examination of the morphology and cytology of the parasite was made. The results of the work are summarised in this paper.

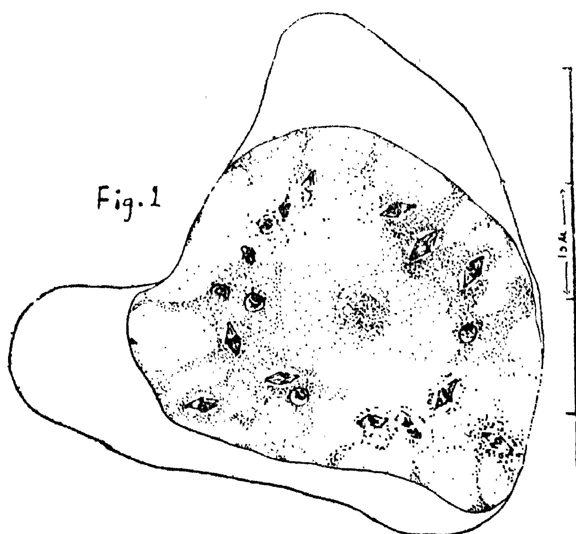
Table I

Cystopus Species	Sporangiophores	Conidia	Oospores
C. candidus Wakefield, E.M. (1927)	28·40 × 12·15 (18) μ	12·20 × 22 μ thin-walled	40·55 μ
C. candidus Wilson, G. W. (1907a)	35·40 × 15·17 μ	15·18 μ thin-walled	40·55
Cystopus sp. on *Cardamine subumbellata*	22·33 × 11·15 μ	11·15 × 15·19 μ	35·50 μ
C. tragopogonis Wakefield, E.M. (1927)	15·20 × 50·80 μ	15·22 × 15·18 μ equatorial thickening	44·75 μ
C. tragopogonis Wilson, G. W. (1907a)	12·15 × 40·50 μ	12·15 × 18·22 μ equatorial thickening	44·68 μ

Cardamine subumbellata plants are found growing wild in the western ghats—Sinhgarh, Lonavla, Khandala, Matheran, M'war—where the rains are heavy. The plants are seen infected generally in the latter half of July. The symptoms produced on the host are those usually described for *C. candidus* on other host plants. A slight hypertrophy is often noticed in the stem and the inflorescence, the latter in that case showing some malformation. The oospores are found in the soft tissues of the hypertrophied parts of the host. Examination of a large number of oospores brought to light a variation from the typical sculpture of *C. candidus*. The ornamentations of the epispore of this form show the gradations between the regular polygonal areoles formed by the characteristic reticulated thickening of the epispore of *Cystopus bliti* (Biv.) and the irregular tuberculated and ridged sculpture characteristic of *C. candidus* (Fig. 2).



Proceeding to the study of a cytological phenomena connected with oogenesis and fertilization it was found that while this form of Cystopus differs in no essential details as regards the early stages of sex organs from those described for *C. candidus*, it shows a striking difference when the oosphere begins to be delimited. From Stevens' (1901) account it is clear that in the maturation of the oosphere the periplasm and the ooplasm are not differentiated until the second mitosis is complete and the stage of zonation is never observed. In this form the ooplasm and the periplasm are marked out shortly after the inception of the first nuclear division when the division figures pass towards the periphery and arrange themselves in a broad belt of dense cytoplasm forming a hollow sphere and exhibiting the so-called stage of zonation (Fig. 1). Ultimately the oosphere is reduced to a uninucleate condition but the manner in which this has been accomplished is different in these two forms due to the interpolation of the stage of zonation during the maturation of the oosphere in the form under investigation. In the further process of fertilization and formation of oospore these forms completely concur.



Again the oospore of the form on *Cardamine subumbellata* often completely fills the cavity of the oogonium. The wall of the oogonium becomes appreciably thick and to it the protuberances on the epispore appear to touch and adhere. In perfectly mature oospores the oogonial wall between the ridges breaks away. Whether the parts of the oogonial wall touching the ridges persist could not be determined. Any such relation between the oogonial wall and the oospore, so far as the writer knows, is not found in any species of Cystopus except in *Cystopus evolvuli*, as described in the writer's (Damle, 1943) earlier paper, in which a definite fusion has been observed.

Thus unlike *C. candidus* the oosphere of the form on *Cardamine subumbellata* in its development passes through a phase very characteristic of *C. platensis*, *C. portulacae* (DC.), *C. bliti* and *C. tragopogonis* (Schröt.) called the stage of zonation and then subsequently the maturation of the uninucleate oosphere differs markedly from that of *C. candidus*. Secondly, the ornamentations of the epispore show grades between typical reticulations of *C. bliti* and irregular ridges of *C. candidus*.

With such characters the Cystopus on *Cardamine subumbellata* cannot be looked upon as identical with *C. candidus*. The only other species of Cystopus to which it very nearly approaches is *C. tragopogonis*, from which the former differs in being parasitic on a Cruciferous host and in possessing smaller oospores with intermediate sculpture (see Table I). The writer is inclined to regard both the morphological and cytological differences from the typical *C. candidus* as justifying the separation of the form on *Cardamine subumbellata* into a new species and proposes to name it as *Cystopus intermediatus*. Its diagnosis is given below. Comparing the present form with other Cystopus species arranged in Stevens' evolutionary series it would be seen that it takes its place between *C. tragopogonis* and *C. candidus*. It is an open question whether this new species could have originated by hybridization of a form (with typical reticulations of the oospore) like *C. bliti* or *C. tragopogonis*, and a form (with a typical irregularly ridged oospore) like *C. candidus*.

Cystopus intermediatus spec. nov.

Sori on leaves hypophyllous, less on rachis and very scattered on the stem and siliquas, cause hypertrophy in the stem and inflorescence.

Sporangiophores stunted, irregularly arranged, hyaline, clavate, measuring 22-33 (26-31 more common) × 11-15 μ.

Conidia roundish and usually broader than long, thin-walled, measuring 11-15 × 15-19μ.

Oospores in the hypertrophied parts of the host, light yellow, epispore ornamented with both reticulated and tuberculated markings, measuring 35-50μ.

Hab.—In shoots of *Cardamine subumbellata* causing hypertrophy in the stem and the inflorescence, at Lonavla, 17th July 1939, type deposited in Biology Department, Fergusson College, Poona.

The writer wishes to acknowledge his indebtedness to Prof. S. L. Ajrekar for his helpful suggestions in this work.

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THE BIOLOGY OF THE FISHES OF THE MAHIM CREEK, BOMBAY

I

By

C. J. GEORGE AND N. S. DESAI,

Department of Biology, Wilson College, Bombay

INTRODUCTION

BEFORE the introduction of the International Scheme for Fishery Investigation in 1902, investigations in fisheries were mainly confined to the elucidation of the life-histories of food fishes and other edible marine animals. One of the earliest of such attempts was that of Sar (1865) who studied the spawning of the Cod. Similar problems formed the basis of further study, by many marine Biologists of the time, working at the various Marine Biological Research Centres. The opening of the International scheme for Fishery Investigation ushered a new era in the field of Marine Biological Research and gave a fresh impetus to research work in Fisheries both in England and in the Continents of Europe and America. As a result, numerous problems covering almost all branches of Marine Biology were investigated at the various stations established for the purpose, throughout the world, and the information available to-day on the different branches of Marine Biology is vast.

The fishery research that is being conducted can be grouped under two main categories, hydrographic and biological. Little has been done in India in the way of hydrographic work. Our knowledge about the biology of many of the Indian fishes is also scanty. There is a pressing need for biological information regarding the more esteemed of our food fishes. The fish supply of India is very rich. The statistics issued by the Department of Fisheries, Madras, in 1917 though dealt with only a small portion of our coast line, namely that portion of the sea that forms the sea board of the Province of Madras (about 240 miles), yet, the interesting fact brought to light was that the Madras fishermen fishing within sight of their huts and using the most primitive types of instruments could catch as much fish as the Scottish fishermen fishing along a wide length of the sea and using the most up-to-date appliances. The obvious conclusion therefore is that our Indian waters are as productive as the Scottish waters which are considered one of the best fishing grounds of the world.

A study of the biology of the fishes of the Bombay coast is an urgent necessity. Such a study, however, will take several years and will require many wholetime workers and considerable amount of money. The study of the biology of the fishes of the Mahim creek was therefore undertaken as a preliminary step. This creek forms a small part of the long stretch of the Salsette coast and is easily accessible from Bombay.

The investigation was conducted on the following main lines :—(1) The determination of the systematic position of the fishes found ; (2) Assessing their relative abundance and fluctuations during the various seasons of the year ; (3) Examination of their food ; (4) Examination of their reproductive organs and collection of their fry with a view to finding out the breeding periods.

MATERIAL AND METHOD

An intensive collection extending over two years, of every type of fish caught in the creek was made. In all 71 species of fishes are recorded.

For assessing the relative abundance of fishes during the various seasons, the following method was used. A tenth part of the morning's catch of 5 fishermen selected at random was bought once a week. The different species of fishes represented in the catch were then assorted. By so doing, the proportions of different species to the total catch, as also the relative abundance of fishes during a particular period could be ascertained. For example, out of 138 specimens bought in bulk on 10th July 1936, there were 5 specimens belonging to *Hemirhamphus gaimardi* while there were 12 specimens belonging to *Mugil borneensis* and 15 specimens to *Trypauchen vagina*. That showed that Mugils and Trypauchens were found in greater abundance than *Hemirhamphus gaimardi* during that period. From these weekly statistics the relative abundance during the various seasons of the year was calculated.

The physical factors of the surrounding waters, such as temperature and salinity which might have influenced the seasonal fluctuations in their numbers were also recorded every time the collections were made. For the determination of the surface salinity, water samples from the fishing ground were taken every time the collection of fishes was made, and their salinities determined by titration for chlorine. The temperature of the surface waters was also determined at the same time as the samples of water for salinity were taken. Since many fishes are not surface dwellers, but live at various depths, it was of importance to have an idea of the vertical distribution of salinity and temperature as well. For this reason, water samples at a depth of 10 feet were taken and their salinity and temperature determined. Since the waters of the creek are not deeper than 15 ft. it was deemed sufficient to take readings at a depth of about 10 feet. For taking water samples from such a depth the following device was used. An air-tight stoppered bottle and a thermometer were attached to a rod about 12 feet long, graduated in feet and inches. Through the stopper of the bottle a chord was passed and the bottle lowered in water at the desired depth. The graduated rod indicated the depth at which the bottle was sunk. The bottle was then opened by pulling the chord and thus filled with water. The rod was then quickly pulled out of water and the temperature was noted. The samples of water were taken to the laboratory for the determination of their salinities. In order to minimise error the process was repeated ten times and the mean of the readings taken.

The investigation on the food of the various fishes was carried out mainly by examining their stomach contents. These observations were tallied with the fauna and flora available in the creek at the particular periods.

THE FISHES CAUGHT IN THE CREEK

The 71 species of fishes enumerated in the list below form the major portion of the fish fauna of the Mahim creek.

(1) *Ambassis gymnocephalus* (Lacep).
(2) *Ambassis sp.*
(3) *Arius thalassinus* (Rupp).
(4) *Batrachus grunniens* (Bloch).
(5) *Boleophthalmus boddærti* (Pall).
(6) *Boleophthalmus dussumieri* C.V.
(7) *Bregmaceros macclellandi* Thompson.
(8) *Caranx (Selar) mate* (C.V.).
(9) *Chirocentrus dorab* (Forsk).
(10) *Coilia dussumieri* C.V.
*(11) *Cybium kuhlii* C.V.
*(12) *Cybium interruptum* C.V.
(13) *Cynoglossus cynoglossus* Ham.
(14) *Cynoglossus brevis* Gunther.
(15) *Cynoglossus macrolepidotus* (Bleeker).
(16) *Dorosoma sp.*.
(17) *Elops saurus* Linn.
*(18) *Engraulis malabaricus* (C.V.).
*(19) *Engraulis dussumieri* C.V.
*(20) *Engraulis sp.*
*(21) *Engraulis sp.*
*(22) *Engraulis sp.*
(23) *Gerres setifer* (Ham).
(24) *Glossogobius giuris* (Ham).
(25) *Gobius ocellatus* Day.
(26) *Gobius viridipunctatus* Day.
*(27) *Hemirhamphus gaimardi* C.V.
*(28) *Hilsa toli* (C.V.).
*(29) *Lates calcarifer* (Bl.).
(30) *Leiognathus lineolatus* (C.V.).
(31) *Lutjanus argentimaculatus* (Forsk).
(32) *Lutjanus vaigiensis* (Q.G.).
(33) *Megalops cyprinoides* (Broussonet).
*(34) *Mugil borneensis* Bleeker.
*(35) *Mugil oeur* (Forsk).
(36) *Muraenesox cinereus* (Forsk).
(37) *Mystus gulio* (Ham).
(38) *Nematolosa nasus* (Bloch).
(39) *Ophichthys boro.* (Ham).
(40) *Osteogeniosus militaris* (Linn).
(41) *Otolithus maculatus* (C.V.).
(42) *Otolithoides brunneus* (Day).
(43) *Parachaeturichthys polynemus* (Bleeker).
(44) *Pellona filigera* C.V.
*(45) *Pellona motius* (Ham).
*(46) *Pellona sp.*
(47) *Platycephalus punctatus* C.V.
(48) *Platycephalus sp.*
*(49) *Polynemus indicus* Shaw.
*(50) *Polynemus paradiseus* Linn.
(51) *Pomadasys argyreus* (C.V.).
(52) *Peeudorhombhus arsius* (Ham).
(53) *Eleutheronema tetradactylum* (Shaw).
(54) *Scatophagus argus* (Bloch).
(55) *Sciaena belangeri* (C.V.).
(56) *Sciaena dussumieri* (C.V.).
*(57) *Sillago sihama* (Forsk).
*(58) *Scomber microlepidotus* Ruppell.
(59) *Spheroides oblongus* (Bloch).
*(60) *Sparus berda* Forsk.
(61) *Synaptura orientalis* (Bl.Schn.).
(62) *Atropus atropus* (Bl. Schn.).
*(63) *Therapon jarbua* (Forsk).
*(64) *Therapon puta* C.V.
(65) *Tetradon sceleratus* (Forster).
(66) *Triacanthus brevirostris* (Temm. Schn.).
(67) *Trichiurus haumela* (Forsk).
(68) *Trypauchen vagina* (Bl.).
(69) *Tylosurus strongylurus* (V. Hass.).
(70) *Upeneoides caeruleus* Day.
(71) *Pogonogobius planifrons* Day.

In the above list those that are marked with an asterisk have a greater demand in the market and are hereafter referred to as food fishes.

Specimens of *Mugil borneensis* and *Mugil oeur* fished in the creek had a size ranging between 5 inches and about a foot in length. Specimens between 5 and 8 inches were very common and were caught throughout the year. Young specimens which were caught in abundance during the winter season had a size ranging between 1 and 2 inches in length. *Mugil oeur* according to Day grows to at least three feet in length but such

specimens were never caught at the creek. Specimens about a foot in length were occasionally found.

Hemirhamphus gaimardi is a coastal fish which ascends the creek in the rainy season and then again in winter when they are seen to have mature reproductive organs. The size of this fish, caught at the creek, ranges between 5-7 inches in length.

Therapon jarbua and *Therapon puta* though marine are estuarine as well and are found in good numbers in the creek all throughout the year. According to Day specimens of *Therapon jarbua* grow to about 12 inches in length. Such specimens were never available at the creek. Specimens that are commonly found range between 3-5 inches in length.

Lutjanus argentimaculatus and *Sparus berda* are considered good food fishes. The specimens of *L. argentimaculatus* collected from the creek range between 7-10 inches in length. According to Day this fish attains upwards of two feet in length but such specimens were not seen at the creek. *Sparus berda* are found more abundantly than *L. argentimaculatus* and range between 3-5 inches in length.

Big specimens of *Sillago sihama* ranging a foot and upwards in length were occasionally caught in the creek. Specimens that are commonly found throughout the year, however, range between 5-8 inches in length.

The specimens of *Pellona*, *Hilsa*, and *Engraulis* caught in the creek had only a size ranging between 2-6 inches in length. Of these, *H. toli is* said to attain 2-3 feet in length.

Polynemus indicus, *paradiseus*, and *Scomber microlepidotus* are marine fishes which are sometimes found in the creek. According to Day *P. indicus* attains 4 feet in length while *P. paradiseus* attains 9 inches. Two of the specimens of *P. indicus* caught at the creek were about 10 inches in length while the rest were less, below 8 inches in length. These fishes are regarded as excellent food. *Scomber microlepidotus* collected ranged between 4-6 inches in length, though it is said to grow to a length of 10 inches.

Lates calcarifer according to Day are marine fishes, largely frequenting the brackish waters. The fish has been recorded to grow to 5 feet in length. The specimens collected from the creek, however, were only between 5-8 inches in length.

The common marine food fishes such as *Stromateus cinerius*, *Stromateus niger*, *Harpodon nehereus* abundant along the coast were never seen in the creek. It seems that these fishes do not frequent shallow waters.

The absence of larger specimens in the creek might be due to several causes. In the case of the permanent inhabitants of the creek, it is primarily due to the intense fishing there, and in the case of others probably to the shallowness of the waters.

RELATIVE ABUNDANCE OF THE VARIOUS SPECIES

The relative abundance of the various species and their fluctuations during the various seasons of the year were ascertained by taking counts as mentioned before. The following tables give the total number of fishes and the number of individual food fishes collected during the respective seasons, *viz.*, the *Rainy season*, the *Dry season*, the *Winter season*, and the *Summer season* of the years 1936-37 and 1937-38. Only those fishes which have importance as food fishes and those that are obviously seasonal are mentioned in the tables.

The Rainy Season (From 15th June to End of Sept.)

Season	Total Number of Fishes Collected		Number of Individual Food Fishes		Genus and Species
	Year 1936-37	Year 1937-38	Year 1936-37	Year 1937-38	
			135	191	*Mugils.*
			74	110	*Hemirhamphus.*
			91	125	*Therapons.*
			104	149	*Trypauchen.*
			69	100	*Engraulis.*
			15	22	*Polynemus.*
			52	91	*Diff. Sp. of Pleuronectidae.*
			144	159	*Pellona.*
Rainy			105	142	*Hilsa.*
Season	1633	2439	26	67	*Sillago.*
			65	91	*Sparus.*
			17	40	*Lutjanus.*
			98	110	*Trichiurus.*
			12	31	*Lates.*
			626	1011	Other Species.

From the above figures for the Rainy season it will be seen that, fishes, including the better types, were caught in sufficiently good numbers during these days. The species which occur in larger numbers are the Mugils, *Trypauchen vagina*, different species of Pellona, *Hilsa toli*, and *Trichiurus haumela*. Next in order of abundance come *Hemirhamphus gaimardi*, *Therapon jarbua*, and *T. puta*, different species of Engraulis, the Pleuronectidae, *Sparus berda* and *Sillago sihama*. Polynemus and Lutjanus were found in very small numbers, while a few specimens of *Lates calcarifer* were found. From the numbers, collected in the Rainy season of the two years, it will be seen that the fishes collected in the year 1937-38 were greater than in the year 1936-37.

The Dry Season (Oct. and Nov.)

Season	Total Number of Fishes Collected		Number of Individual Food Fishes		Genus and Species
	Year 1936-37	Year 1937-38	Year 1936-37	Year 1937-38	
			67	85	*Mugils.*
			9	11	*Hemirhamphus.*
			31	50	*Therapons.*
			..	2	*Trypauchen.*
			46	52	*Engraulis.*
			6	9	*Polynemus.*
			1	7	*Difft. Sp. of Pleuronectidae.*
			66	70	*Pellona.*
Dry			68	68	*Hilsa.*
Season	575	836	9	23	*Sillago.*
			24	41	*Sparus.*
			10	14	*Lutjanus.*
			5	5	*Trichiurus.*
			15	16	*Lates.*
			218	383	Other Species.

In the Dry season the catch of fish was less in comparison with that of the Rainy season. Specimens of Mugils, Engraulis, Pellona, Hilsa, Sparus, etc., were found in small numbers. Fishes like Hemirhamphus, Trypauchen, Trichiurus and Synaptura which were so abundantly found during the Rainy season were rare during these days. There were several days during the season when these fishes were not represented in the catch at all. It seems that these fishes frequent the creek during the Rainy season and in the subsequent seasons migrate to the sea.

The Winter Season (Dec., Jany., Feb.)

Season	Total Number of Fishes Collected		Number of Individual Food Fishes		Genus and Species
	Year 1936-37	Year 1937-38	Year 1936-37	Year 1937-38	
Winter Season	1277	1398	202	234	*Mugils* (Adults & Young).
			66	80	*Hemirhamphus.*
			42	49	*Therapons.*
			..	..	*Trypauchen.*
			79	92	*Engraulis.*
			4	15	*Polynemus.*
			11	20	*Diff. Sp. of Pleuronectidae*
			148	140	*Pellona.*
			104	118	*Hilsa.*
			28	52	*Sillago.*
			65	76	*Sparus.*
			12	22	*Lutjanus.*
			12	4	*Trichiurus.*
			12	15	*Lates.*
			492	481	Other Species.

From the figures it is seen that the catch in the Winter season was slightly better than in the Dry season. Bigger specimens of fishes during this period were few and the catch was characterised by a greater abundance of young ones than adults.

From the very beginning of December the young ones of Mugils began to be represented in the catch and by the beginning of January young ones belonging to the different species of Clupidae were to be found in good numbers. Besides these, young ones of Gobidae, Therapons, Sparus, Lutjanus were frequently found in the catch. Trypauchen vagina was not collected throughout the whole Winter season, while Trichiurus, and Synaptura were caught in very small numbers. Bigger specimens of Mugils, Therapons, Lutjanus, Pellona, Hilsa were also found in moderate numbers. *Hemirhamphus gaimardi* which was found in good numbers during the Rainy season and which in the intervening Dry season was found in very moderate numbers, was again caught in greater numbers during this season—almost as much as that in the Rainy season. The specimens were adult ones and had well developed reproductive organs.

The Summer Season (March, April, May, First Half of June)

Season	Total Number of Fishes Collected		Number of Individual Food Fishes		Genus and Species
	Year 1936-37	Year 1937-38	Year 1936-37	Year 1937-38	
Summer Season	847	1147	99	111	*Mugils.*
			30	31	*Hemirhamphus.*
			40	51	*Therapons.*
			3	3	*Trypauchen.*
			60	84	*Engraulis.*
			5	12	*Polynemus.*
			14	28	*Diff. Sp. of Pleuronectidae.*
			70	96	*Pellona.*
			68	80	*Hilsa.*
			16	31	*Sillago.*
			34	54	*Sparus.*
			12	20	*Lutjanus.*
			..	5	*Trichiurus.*
			14	17	*Lates.*
			382	524	Other Species.

Of all seasons, the Summer season gave the poorest yield of fish. There was comparatively a greater amount of yield of fish in the month of March, and the first part of April than in the latter part of April, and May. Almost all the species of fishes were adult ones, and the young ones which were so very conspicuous in the previous season were found in very small numbers. *Mugil borneensis* formed the bulk of the catch. Next in order of abundance were Therapons, Pellona, Hilsa, etc. Specimens of *Gerres setifer* were found in moderate numbers during the earlier part of the month of March. Trypauchen, Polynemus, Sillago, Trichiurus, Lates, etc., were very poorly represented in the catch.

DISCUSSION ON THE VARIATIONS IN THE CATCH

From the tables showing the collection of fish during the different seasons of the years 1936-37 and 1937-38, it was seen that the best catch was during the Rainy season of both the years. Most of the 71 species enumerated in the list were found during these days. The creek is fished well throughout the year. There is no period of the year when the creek is neglected. Therefore the statistics regarding the relative abundance of fishes during the different seasons of the year is more or less reliable. There was a general increase in the catch of fish during the Rainy season and in consequence the fishing operations were carried twice or thrice, during the course of a day as opposed to only once, in the morning, during all the other seasons. The intensive fishing of the creek during the Rainy season might also be due to the fact that no satisfactory fishing is possible in the open sea during these days and the fishermen concentrate more on the creek fishing than on the open sea. It will be pointed out here, however, that even though the creek is fished many times during the course of a day, the collection of fishes for the statistical study was done only once in the morning during the Rainy season as was done in the subsequent seasons and therefore the relatively richer collection during the former season was entirely due to a greater influx of fishes to the creek during that season than any other.

This greater influx of fishes might be ascribed to several causes: (1) Favourable salinity and temperature; (2) the currents and the direction of wind during the Monsoon season; (3) the migration of certain fishes to the creek for breeding purposes; (4) the migration for feeding purposes.

(1) The salinity and temperature and their effects on fishes are discussed in the subsequent section. It might be mentioned here, however, that these are the factors which might be correlated to a greater increase in the catch of fish during the Rainy season.

(2) The currents and the direction of wind might also be responsible to an increase of fishes during these days. It is well known that on the onset of South-west monsoon there are irregular currents set up in the open sea. Some of the smaller types of fishes might have been driven thus into the comparatively calm, shallow waters of the creek. In consequence these waters become the haunts of a number of small fishes.

(3) Some fishes may be migrating to the creek during the Rainy season for spawning purposes. It will be evident from the breeding records given elsewhere that several species spawn during the Rainy season and those fishes which undertake an anadromus migration for the purposes of spawning, naturally prefer the shallow waters of the creek.

(4) Lastly during the Rainy season a good deal of animal and vegetable debris is washed to the creek. This serves as food for a number of smaller types of fishes and consequently they frequent these waters. For those fishes which migrate to the creek for the purpose of spawning, the question of the abundance of food is of little significance because during the breeding period their feeding activity is mostly at a low level and they subsist on the fat already stored in the body. (Ghazzawii, 1921).

It will therefore be seen that the problem as to the abundance of fishes during any particular time is a many-sided one, in which the influence of any single factor cannot be accurately assessed, unless an unbroken series of data extending over a number of years is collected and the behaviour of different fishes to each of these factors understood.

On the basis of the factors mentioned above, the fishes caught in the creek during theRainy season can be grouped under three main categories: (1) those that are there as the permanent inhabitants of the creek; (2) those that come for breeding purposes; (3) those that migrate for feeding; (4) those that frequent the creek owing to the unfavourable conditions in the sea. In the first category can be included all those fishes which do not leave the creek but are found throughout the year. Such fishes are the Mugils, Engraulis, Therapons, Sparus, Lutjanus, Pellona, and Hilsa. In the second category fall fishes belonging to the family Gobidae, Siluridae and Pleuronectidae. In the third and fourth categories can be included fished like Trypauchen, Hermirhamphus, Trichiurus, Polynemus and Scomber.

On a cursory examination of the plankton of the creek during the Rainy season it was found that the creek waters were neither rich in Copepods nor Diatoms, both of which serve as excellent food for a number of smaller types of fishes. Except the animal and vegetable debris washed into

the waters of the creek by the rains, there was not as much abundance of food as it was found in the subsequent season and the influx of fishes cannot be very much for the purpose of feeding.

During the Dry season there was observed a considerable fall in the catch of fish. As will be seen from the tables of salinity and temperature, given in the following chapter, both the salinity and temperature were higher in this season, especially during the month of October, than in the previous one, and the fall in the catch of fish might be correlated to an increase in the salinity and temperature of the surrounding waters. Besides, the unfavourable conditions in the sea during the Rainy season, having restored to normal, some fishes like Hemirhamphus, Trichiurus, Trypauchen, Polynemus and Scomber, migrate back to the sea. Spent fishes such as those belonging to the family Gobidae, Siluridae, Sciaenidae, Pleuronectidae, were also poorly represented in the catch. The spawning period being over, they might have migrated back to the sea. The catch then consisted of Mugils of different stages, Therapons, Engraulis, Pellona, Hilsa and Sparus, all of which are the permanent inhabitants of the creek. Compared to the previous season these fishes were caught in lesser numbers.

In the Winter season some of the species of fish such as *Hemirhamphus gaimardi* and some species of Gobidae, etc., which had migrated to the sea in the intervening Dry season had again returned to the creek for the purpose of spawning and were again caught in greater abundance. Besides, Winter was seen to be the peak season for the plankton in the creek and the young ones of fishes, especially those of Mugils, Clupeidae, Therapons, Sparus, Gobids, etc., which feed voraciously on the plankton organisms were found in much greater abundance than the adults. Adult fishes that were caught in moderate numbers were, Mugils, Gobids, Therapons, Clupeids, Hemirhamphus, etc.

In the Summer season the catch of fish was the least. In the month of March there was more catch than in the succeeding months. All the migratory fishes had left the creek. On a general examination of the invertebrate fauna it was found to be quite rich in Copepods, Coelenteates, Polychaetes, etc. Diatoms were also found in moderate numbers. It does not seem likely that the fishes might have migrated for want of food. The temperature and salinity reach their maximum during these days. The waters of the creek are rendered foul and the sewage is not readily removed as there is less flow into the sea at this time. This also probably accounts for the low catch during these months, as few fish migrate from the sea.

[*To be continued*]

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